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CONTENTS

PAGE

EDITORIAL

Notes 66
Effluent and Water Treatment Exhibition ; British Mining Equipment Export Association ; The Story of International Nickel ; Coal Discovery in Oxfordshire ; Computer Control for Steel Furnaces.

Warren Spring in 1960 67
The first full year of activities is reviewed.

Australian Mineral Industry 68
Note is taken of preliminary results now issued.

Institution of Mining Engineers 68
A brief account of the Summer Meeting at Nottingham.

MONTHLY REVIEW 69

DIVIDENDS DECLARED 72

METAL PRICES 72

ARTICLES

Note on the Perimeter Blast
H. G. Jarman 73
New explosives designed to make clean break.

Developments in Titanium
M. Schofield 76
History and current developments reviewed.

Shipping Sulphur in Liquid Form
J. Grindrod 80
A recent technique in the U.S.A. described.

Stone for Asphalt Roofing
A. E. Williams 82
Specialized crushing techniques are reviewed.

ORE-DRESSING NOTES 84
Israeli Phosphates ; Modified Diamond Jig ; Steel *vs.* Pebbles in the Ball-Mill.

SIXTH INTERNATIONAL MINERAL PROCESSING CONGRESS 86

BOOK REVIEWS

Maucher and Rehwald's " Bildkartei der Erzmikroscopie "
S. E. Hollingworth 87

Mendelsohn's " The Geology of the Northern Rhodesian Copperbelt ... 88

LETTER TO THE EDITOR

The Witwatersrand Controversy
C. F. Davidson 88

PAGE

ENGINEERING LOG 90

SURVEY AROUND THE CORNISH COAST 92

NEWS LETTERS

British Columbia 94
Production ; Placer Development, Ltd. ; Skeena ; Nicola ; Greenwood ; Golden ; Yukon ; Alaska.

Eastern Canada 95
Porcupine ; North-Western Ontario ; Sudbury ; Manitoba ; Quebec.

Australia 96
Costs and Industry ; New Power Plant ; Beryl ; State-owned Mines ; Tableland Tin ; Power Projects ; Coal ; Uranium.

Far East 98
Malaya ; India.

Southern Africa 99
Institution Centenary ; Winder Arresters ; New Railway ; News from the Mines ; New Drill Steel

TRADE NOTES

Underground Coal Carrier 102
Large Dragline Bucket 103
Battery Locomotives 103

PERSONAL 104

METAL MARKETS 105

STATISTICS OF PRODUCTION 109

PRICES OF CHEMICALS 111

SHARE QUOTATIONS 112

MINING DIGEST

Mining at Rustenburg Platinum
C. B. Beath and others 113

Denbeath Coal Preparation Plant 117

TBE for Beryl Recovery
A. Mitzmager and J. Mizrahi 118

Underground Settlers ..... *J. W. de Villiers* 119

TRADE PARAGRAPHS 121

RECENT PATENTS PUBLISHED 126

NEW BOOKS, PAMPHLETS, ETC. 126

SELECTED INDEX TO CURRENT LITERATURE 127

EDITORIAL

THE increasingly severe restrictions now being imposed everywhere by river authorities on effluent discharge lends particular interest to the second Effluent and Water Treatment Exhibition and Convention to be held in London from October 31 to November 3 next. The sponsors of the Exhibition, to be staged in the Seymour Hall, draw attention to the fact that the growing volume of water required for industry cannot always be provided economically from available sources and that the recovery of used water is of prime importance. Both subjects are to be represented at the Exhibition by new designs and techniques.

IT is of interest to learn that the British Mining Equipment Export Association is to have a stand at this Autumn's Zagreb International Fair. The Association, which has at present 46 members, was formed, it will be recalled, to act as a liaison between British manufacturers of mining equipment on the one hand and Government and international organizations on the other. It also aims to provide information and various other services which can be more efficiently done on a collective basis. This is thought to be the first occasion on which a group stand of mining equipment manufacturers has been organized at an international Trade Fair.

NOTICE of the publication of the book by Dr. John F. Thompson and Norman Beasley entitled " For the Years to Come " appeared in the MAGAZINE for February. This work, " A Story of International Nickel of Canada," is in essence a profile of Dr. Thompson himself. It is a handsome exposition of the approach and mental attitude he has brought to bear in the development of a vigorous and prosperous industrial organization. Dr. Thompson, who recently retired as chairman of International Nickel to become honorary chairman, joined the company in 1906 as a working metallurgist to take over the company's first research laboratory, becoming manager of operations in 1921 and supervising the construction and operations at the Huntingdon works. In 1928 he was elected assistant to the president of the company, a director in 1931, vice-president in 1932, executive vice-president in 1936, president in 1949 and, finally, chairman, in addition to president, in 1951. His collaborator has helped the senior author the better to show that " from the beginning Inco has been run like a small company " and that that is a philosophy that has paid dividends.

DRILLING by the Geological Survey at Apley Barn, Witney, ten miles west-north-west of Oxford, began in August, 1960. Started in the great Oolite the hole passed into rocks of the Triassic system and then, below the provisional base of that system, at about 820 ft., into reddened sand stones. These gave place, first, to reddened and then to grey mud stones containing plants and crustacea of Upper-Coal Measures age. A number of thin coal seams were penetrated between 1,005 ft. and 1,928 ft., including a 3-ft. seam at 1,661 ft. At the end of the year the depth was 1,928 ft. and coring is continuing and has now reached a depth of over 4,500 ft. Between 1,928 ft. and the present depths coals have been found at several horizons, including some of thicknesses exceeding 2 ft. 6 in. It is hoped to continue boring to establish whether productive (middle) Coal Measures will be found. In the meantime the National Coal Board is analysing coals already drilled. This is the first coal to be found in Oxfordshire of a workable thickness and the results obtained so far are sufficiently promising to justify further exploration in the area.

COMPUTER control for what are thought to be the world's largest basic oxygen steel furnaces is about to be installed, according to M. Robert Remillon, president of the Co. Européenne d'Automatisme Electronique. The system is to be set up at the Detroit plant of Great Lakes Steel and in controlling furnace operation it will be able to take into account raw material and furnace characteristics, as well as specifications for the end product, and determine the quantity and chemical composition of the steel produced. From the raw material characteristics, furnace characteristics, and finished-ingot specifications the computer will determine the amounts and types of additives required and then control the heat generated within the vessel through the rate and duration of the oxygen flow. Data accumulation capabilities of the system will permit the computer to relate finished ingot characteristics with the furnace data for specific ingots so that the best set of production conditions can be determined for subsequent batches. This is an "adaptive" control system that enables the computer control programme to be updated automatically as more is learned about furnace operation.

Warren Spring in 1960

Published for the Department of Scientific and Industrial Research last month the Report of the Warren Spring Laboratory for 1960 covers the first full year of its activity.[1] In his introduction Sir Harry Jephcott, chairman of the Research Council and of the Laboratory's Steering Committee, draws particular attention to the success of the Mineral Processing Division in attracting work on a "repayment" basis. One of the reasons for setting up the Laboratory, he points out, was to provide centralized facilities available to other Government Departments and to industry, three-quarters of the work of the Mineral Processing Division being financed by the Colonial Office, by the U.K. Atomic Energy Authority, or by industry. Much of the repayment work carried out for industry has, however, been short-term, but while it is hoped that the short-term projects will lead to the need for longer-term work the situation is considered satisfactory at this early stage. The problems involved in integrating sponsored work with research financed by the D.S.I.R., without causing large fluctuations in the demand for staff and accommodation, have been considered and it has been agreed that there is no need at present to limit the amount of repayment work that can be carried out at Warren Spring.

In the Mineral Processing Department itself the Director reports that the installation of the major items of equipment has been substantially completed and that it is possible to report progress in a number of directions. For instance, studies of the use of surface-active reagents to improve efficiency in wet grinding have proved promising, while a review of current research in the field of supercritical grinding was completed and published during the year, as was a similar review of hydrocyclone applications.[1] A deal of fundamental work on flotation processes, on high-tension separation, and on particular gravity machines is also going ahead, as is the investigation on the selective recovery of base metals from aqueous solutions using kerosene solutions of napthenic acid. For this work a continuous concurrent-flow bench unit, permitting the extraction of one element from the aqueous phase and stripping from the organic phase with recycle of the organic medium, has been operated successfully, particularly on the separation of copper and nickel from a mixed sulphide concentrate. After roasting and leaching iron was first removed from the leach liquor by precipitation and filtration. Good recoveries of copper and nickel were then obtained in the subsequent liquid-liquid separation and the purity of the strip solutions obtained was suitable for metal recovery by electrolysis. The industrial application of this process for the separation of copper from cobalt and copper from nickel appears to be feasible both technically and economically. At the same time the possibility of recovering niobium concentrates economically from a highly-complex alluvial deposit in which 70% of the niobium occurs in the sub-sieve range, largely as a barium pyrochlore, has been investigated. Tests showed that volatilization of niobium in the presence of goethite (FeO(OH)) only began after the removal of the bulk of the iron as the volatile chloride, because HCl reacts more readily and rapidly

[1] London: H.M. Stationery Office. Price 3s. 4d., post free.

[1] Mineral Processing Information Notes Nos. 1 and 2, Warren Spring Laboratory, 1960.

with iron oxide. Studies at the bench involving calcination, hydration, and desliming to effect the concentration and liberation of monazite from a carbonatite gangue have also given promising results.

The director reports that on the advice of the Joint Mineral Processing Research Sub-Committee priority is to be given to exploration of the possibilities of full or partial control in processing work, the first phase to involve a plant-scale experiment. A trial of computer control of a flotation separation on an ore of varying composition has already proved promising. However, in most cases, it is stated, repayment work has called for the adaptation of standard techniques to suit particular materials rather than a search for new processes. During the year work was undertaken on 22 different projects, of which 13 have been completed. Six of the investigations were concerned with the beneficiation of United Kingdom mineral deposits, but primary base-metal sulphide and oxidized sulphide ores, with one exception, have not appeared as subjects for applied research. The director infers that industry itself is well able to handle the development of this class of ore.

Australian Mineral Industry

In a recent statement the Australian Minister for National Development, Senator the Hon. W. H. Spooner, draws attention to preliminary data on mineral production from the Commonwealth in 1960. The latest issue of the *Australian Mineral Industry Quarterly Review*, he says, shows that although low prices and marketing difficulties affected certain sections of the industry the overall picture was one of expansion, in particular significant increases in production coming from coal (black and brown), copper, iron ore, zinc, tungsten, and ilmenite. The *Review*, published by the Bureau of Mineral Resources, states that while the total value of output of primary products for the year will not be available for some time yet some increase on the £213,000,000 for 1959 may be expected.

Summarizing the figures available the Minister states that Australian mineral exports, excluding gold and uranium oxide, were £62,000,000 in 1960, as compared with £54,000,000 in 1959 and £49,800,000 in 1958. There was a big increase in the value of coal and copper exported, but, as in recent years, the value of lead exports continued to be well down because of low prices and voluntary restriction of offerings by producers. The value of mineral imports, excluding gold, was again higher at £98,500,000, of which crude oil accounted for £74,700,000 or 75%. Imports of aluminium were substantially increased, as were those of refined tin.

Institution of Mining Engineers

Reference was made in the March issue to the fact that the summer meeting of the Institution of Mining Engineers was to be held this year in Nottingham from July 19 to 21 at the invitation of the President and Council of the Midland Counties Institution of Engineers. Coupled with the meeting was an exhibition of the work of the Safety in Mines Research Establishment. Two technical papers provided the basis of discussion for the first day's proceedings, the first, by Ir. A. Hellemans, of Holland, dealing with the inter-relation of British and Continental mining practices, particularly with the vital influence of differing geological conditions. In the second paper Dr. D. T. A. Townend and Mr. R. L. Brown, director general and director of the Basic Research Laboratories of the British Coal Utilization Research Association, described the various uses of the different types of coal available in this country. It was suggested that progressive increase in the use of mechanical firing in industry and of pulverized fuel in power stations was well suited to current trends in the production of small coal and predicted that gas and electricity will play an increasingly important part in the industrial and domestic markets and provide the major outlets for coal and its solid-fuel derivatives. The authors said that gas, if cheap enough, has advantages over other fuels, since it causes negligible atmospheric pollution and plant which consumed it could readily be made flexible, efficient, and automatic. They concluded that further advances in mechanization of mines and automation of coal-using equipment can meet the challenge of other fuels only if production, preparation, and use are more closely integrated.

In the two concluding days of the meeting visits were paid to various collieries and other places of interest in the area. Included, for instance, were the Avenue Carbonization and Chemical Plant of the N.C.B., and the British Coke Research Association Station, both near Chesterfield, as well as the Central Workshop and Stores for No. 6 Area of the Board.

MONTHLY REVIEW

Introduction.—The Chancellor of the Exchequer's plans to curb inflation introduced in his "Little Budget" last month, including his suggestion of a "wage pause", coupled with the tense international situation arising over Berlin, have naturally added to the unsettled conditions in business created by Britain's planned approach to the Common Market. While interest has been created by the Chancellor's further plan for a joint examination by industry and the Government into economic prospects, production stays quietly progressive, with metal prices steady at recent levels.

South Africa.—Earlier this month shareholders of HARTEBEESTFONTEIN GOLD MINING were informed that the Vaal Reef had been intersected in No. 4 vertical shaft at 6,656 ft. below collar and a full exposure of the Reef over the periphery of the shaft was completed at 6,660 ft. The Reef was sampled at 5-ft. intervals and 17 sections gave an average value of 5·22 dwt. of gold and 0·62 lb. of uranium oxide per ton over a channel width of 35·8 in.

At BRACKEN MINES development results in the June quarter show that of the 4,418 ft. driven, 2,180 ft. were sampled, resulting in 1,780 ft., equivalent to 82%, being payable with average values of 448 in.-dwt. It is also reported that the erection of the company's reduction works is up to schedule. At LESLIE GOLD MINES 5,402 ft. was driven and 780 ft. sampled, of which 600 ft., equivalent to 77%, proved payable and gave average values of 313 in.-dwt.

It has been reported that the Nippon Kokan Kaisha is to send a survey group to South Africa later this year to conduct a survey of the chrome and manganese mining resources with a view to securing long-term contracts for the supply of raw materials for the Japanese ferro-alloy industry. The Japanese domestic steel industry intends increasing production to 48,000,000 tons per annum by 1970, it is stated.

With the recent dividend notice shareholders of NEW CENTRAL WITWATERSRAND AREAS were informed that, subject to final audit, the profit for the year to June 30 last is R 102,000.

In the three months to June 30 the MESSINA (TRANSVAAL) DEVELOPMENT COMPANY produced 275,560 long tons of ore containing 3,508 tons of recoverable copper.

The report of ROOIBERG MINERALS DEVELOPMENT for the June quarter shows an estimated profit of R 96,613. In the period 323 long tons of tin concentrates was produced.

The FREE STATE DEVELOPMENT AND INVESTMENT CORPORATION announced on August 2 that borehole D.O. 1 situated on the western boundary of sub-division 3 of the farm Doornkom Oost 447, in the district of Viljoenskroon, has been stopped in foot-wall measures of the Vaal Reef at 6,407 ft. The Vaal Reef has not been intersected owing to its displacement by a fault.

South-West Africa.—It has been announced that the TSUMEB CORPORATION is to construct a R 12,000,000 metallurgical plant to smelt and refine ores at present shipped to European and American refineries. A new lead smelter and refinery is scheduled to begin operating in 1963 and a new copper smelter by 1962. In addition, a differential flotation plant, with a capacity of 750 tons daily under construction at Asis, about 65 miles from Tsumeb, should be in production by 1962. The Asis mine has developed reserves totalling 2,000,000 tons of 3·6% copper, 4·4% lead, and 0·5% zinc. The latest plant to begin operating at the Asis mine is a semi-refined, high-grade, germanium dioxide plant, which recovers by-product germanium and has an annual capacity of 10,000 lb.

Southern Rhodesia.—In the three months to June 30 M.T.D. (MANGULA), LTD., milled 307,400 short tons of ore and produced concentrates containing 3,427 long tons of recoverable copper.

Northern Rhodesia.—In the year to March 31 last NCHANGA CONSOLIDATED COPPER MINES treated 4,957,300 short tons of ore and produced 31,941 long tons of blister and 152,059 tons of electrolytic copper, valued at £40,721,182. Operations resulted in a profit of £12,450,128, dividends equal to 7s. a share requiring £9,800,000. Ore reserves at March 31 last were estimated to be 184,166,000 tons averaging 4·63% copper. In his review accompanying the report and accounts the chairman refers to an increase of 4,000,000 tons in the reserve, suggesting that further substantial additions are likely. Nchanga, he thinks, "with its flexibility and large reserves, and the extensions to the plant now being made, is very well placed to take advantage of any increased demand for copper."

The BRITISH SOUTH AFRICA COMPANY announced last month that its estimated revenue from mineral royalties, rents, and fees for the quarter ended June 30, after providing for the payment to the Northern Rhodesia Government of 20% of the net revenue derived from the exercise of its Mineral Rights in Northern Rhodesia, amounted to £2,626,000.

Ghana.—In the report for the June quarter the directors of the ASHANTI GOLDFIELDS CORPORATION recommend a scrip issue of one share for every five held to be fulfilled by capitalization of reserves. An extraordinary meeting is to be held next month to create the necessary additional capital. The estimated profit for the nine months to June 30 is given as £1,326,339.

Sierra Leone.—It has been reported from Sierra Leone that a subsidiary company of the Swiss company, ALUMINIUM INDUSTRIAL A.G., has been formed, called the SIERRA LEONE ORE AND METAL COMPANY. This company has submitted a draft agreement to the Government for consideration, it is stated, and is at present erecting prefabricated houses on their prospecting area near Kangahun, in the Moyamba District. In addition, a hydrographic survey is being started in the Bonthe area in order to find out the depth of the river for the purpose of shipping bauxite.

Nigeria.—In his statement accompanying his report and accounts of CONSOLIDATED TIN SMELTERS, LTD., for the year to March 31 last, the chairman says that the new tin smelter will start production in November. To carry out the project a new company named the MAKERI SMELTING CO. LTD., was incorporated under Nigerian law on March 30, 1961, with authorized capital of N.£500,000 in 5s. shares, of which N.£250,000 is being issued. WILLIAMS, HARVEY, AND CO., LTD., hold 75% of the issued share capital and the balance of the issued share capital has been made available to associates in the tin industry. An option has been given to the Government of the Northern Region to participate at a later date if they so desire, it is stated. Consolidated Tin's profit for the year under review is given as £593,204, dividends equal to 3s. 6d. on the ordinary shares requiring £214,211 of the £587,321 available.

Tanganyika.—It has been reported from Tanganyika that for the first five months of the current year mineral exports have been £180,000 higher than for the same period during 1960, in spite of a drop in lead concentrates from £600,000 to £60,000. Diamond exports are up by £643,550 on last year, gold by £56,518, and tin by £19,220. Total exports for May were below those for May, 1960, by £91,892, although diamonds and tin both showed increases.

The report of the COLONIAL DEVELOPMENT CORPORATION for 1960 states that in the year the MBEYA EXPLORATION COMPANY carried out an extensive programme of exploration and flotation testing. In addition to test work the pilot mill treated 29,000 tons of ore assaying 0·46% Nb_2O_5 to provide gravity concentrates for further work. In the same year TANGOLD MINING treated 202,400 tons of ore and recovered 37,496 oz. of gold, but operations resulted in a loss of £148,778.

With the recent preliminary accounts shareholders of KENTAN GOLD AREAS were informed that the accounts of GEITA GOLD MINING for the year to March 31 last show a working profit of £14,157, as compared with £47,555 for the previous year.

Uganda.—In the year to December 31 last KILEMBE MINES treated 893,467 tons of ore and produced 14,515 long tons of blister copper. The net profit for the year is given as £650,952.

Australia.—In the year to June 30 last BROKEN HILL SOUTH treated 298,800 tons of ore and recovered 48,640 tons of lead concentrates and 54,726 tons of zinc concentrates.

It was announced last month that a joint venture to carry out iron-ore exploration in Western Australia has been formed by CONSOLIDATED GOLD FIELDS (AUSTRALIA), PTY., the CYPRUS MINES CORPORATION, and the UTAH CONSTRUCTION AND MINING COMPANY. Their application to the Western Australian Government for authority to prospect was approved on July 20, 1961, and a ground survey has already begun in the Ellarine Hills region, east of Port Hedland, Western Australia. This is soon to be followed by an airborne magnetometer survey. The three companies have been granted authorities to prospect over an area of 308,256 acres in the Ellarine Hills area. They consider that there are good possibilities for the location of substantial iron-ore deposits and are hopeful of being able to establish a major operation in the region.

At the beginning of August a similar announcement was made to shareholders of the WESTERN MINING CORPORATION. They were advised that the Western Australian Government had accepted the Corporation's tender to mine and export Tallering iron-ore

deposits. These are situated 75 miles inland north-east of the port of Geraldton and if detailed exploration confirms satisfactory grades and tonnages of ore it is expected to develop an export trade with Japan. Geraldton is a deep-water port allowing vessels up to 10,000 tonnage to dock. The company has also been granted an iron-ore prospecting reserve of 50 sq. miles near Morawa, in the Geraldton district, and three prospecting reserves for iron ore of 50 sq. miles each in the North Yilgarn, where reserves are believed from surface reconnaissance to have a very large potential. It is intended to begin prospecting the reserves in the near future.

Reference was made in the July issue to the interest of the WESTERN MINING CORPORATION in the arrangements being made in co-operation with the ALUMINUM CO. OF AMERICA for the establishment of an integrated aluminium industry in Australia. The formation of ALCOA OF AUSTRALIA PTY., LTD., was subsequently announced and it has been stated that Western Mining, in conjunction with NORTH BROKEN HILL and BROKEN HILL SOUTH, will be contributing to the joint venture prospecting and mining rights for bauxite and coal and rights under an agreement with the Government of Western Australia, the brown coal deposit at Anglesea, near Geelong, in Victoria, which will provide the fuel source for the power station that will generate electricity for the aluminium smelter, and land for the smelter and fabricating sites at Point Henry, Geelong.

In a recent circular shareholders of GOLD FIELDS AUSTRALIAN DEVELOPMENT were informed that development work in the southern section of the Mount Ida mine has indicated the possible availability of a tonnage of good-grade gold ore sufficient to permit the continuation of milling for longer than anticipated. This will call for some additional plant and it will also be necessary to carry out maintenance work left in abeyance in view of the previously anticipated exhaustion of the ore reserves. Exploratory work in the northern section of the mine area, however, has not so far met with success and it is being suspended in order to accelerate the more encouraging work in the southern section.

Near Ora Banda workers have opened up the old Cave Hill find. They are following a schistose lode and report dispatches of small nuggets up to 5 oz. in weight. The place had been opened by a shaft sunk to 50 ft. without locating values. The present owners drove only 12 ft. to find the first of their rich patches.

Malaya.—The accounts of SUNGEI KINTA TIN DREDGING for 1960 show a loss of £27,412, as compared with a profit of £14,479 for the previous year.

Shareholders of LOWER PERAK TIN DREDGING have been advised that No. 2 dredge is to be closed down for approximately three weeks from the beginning of August to effect major repairs to the bucket ladder. This is in accordance with the normal maintenance programme for deep-digging dredges.

At an extraordinary meeting of AMPAT TIN DREDGING held on August 2 the resolution to effect the reduction of capital by the repayment to members of 3s. per share in cash was duly passed.

India.—The accounts of the INDIAN COPPER CORPORATION for 1960 show a profit of £1,307,982 and after adding the sum brought in and allowing for taxation a total of £914,626 was available. Of this amount £370,251 is required for a dividend equal to 20%, while £200,000 has been placed to reserve. In the year the mill treated 480,306 short tons of ore, the concentration plant recovering 37,054 tons of concentrates.

Bolivia.—FABULOSA MINES produced 619,313 kg. of fine tin in 1960 and made a profit of Bs. 641,670,900. In addition 2,705 kg. of mineral containing 56·56% bismuth was produced.

The report of ARAMAYO MINES IN BOLIVIA for 1960 show a surplus of Sw. Fr. 603,542 and a total of Sw. Fr. 7,140,158 available. A dividend equal to 4% requires Sw. Fr. 403,200.

Cyprus.—In the year to March 31 last the ESPERANZA COPPER AND SULPHUR COMPANY treated 227,505 tons of Limni ore and produced 9,827 tons of concentrate. In the June quarter, however, 70,863 tons yielded 4,252 tons of concentrates.

Sweden.—The accounts of BOLIDENS GRUVAKTIEBOLOG for 1960 show that the profit was increased to 14,100,000 kronor and the dividend from 9% to 10%. The company's prospecting was intensified in 1960, both in Sweden and elsewhere. Ore reserves, investigated by mining, amounted to the end of the year to about 64,000,000 tons split among 11 mines owned by the company and two leased. The ores consist mainly of complex sulphide ores containing copper, zinc, lead, and sulphur, and sulphide ores containing lead. New investments decided upon in 1960 include a new arsenic refinery and

extensions to the selenium works and the sulphuric acid plant. There is, in addition, to be enlargement of the ore-dressing plant at Laisvall, which treats the ore from the largest lead deposit in Europe, and of the ore-dressing plant at Garpenberg in central Sweden.

Engineers of the ABEM COMPANY, using magnetometers and gravimeters have recently started a geophysical exploration programme to the south and east of Kiruna town centre, as the first stage of a survey to embrace the whole of the Kiruna ore field. The use of newer techniques and instruments will, it is hoped, reveal more details about the ore occurrences lying at greater depths. That the new survey has been started so near the town centre is because LKAB, who operate the Kiruna mine, wish to ensure that the building programme to be carried out by the town authorities is not likely to interfere with any future ore exploitation.

United Kingdom.—With the recent notice of a final dividend of 2s. a share, shareholders of GEEVOR TIN MINES were informed that the profit for the year to March 31 last, before taxation, was £65,613, which compares with £58,463 for the previous year.

Johannesburg Consolidated Investment Co.—In declaring the final dividend for the year ended June 30 last the directors of the Johannesburg Consolidated Investment Company report a profit of £2,426,107 and a total of £2,666,746 available. Of this amount £1,542,227 has been placed to investment reserve, while £898,333 is required for dividends totalling 5s. a share, leaving £226,186 to be carried forward.

DIVIDENDS DECLARED

* Interim. † Final.

(Less Tax unless otherwise stated.)

***Borax (Holdings).**—Def. ord. 4%, payable Sept. 13.

***British Tin Investment Corporation.**—8%, payable Sept. 7.

***Consolidated Mines Selection Co.**—1s., payable Aug. 24.

†Consolidated Tin Smelters.—3s. and 6d. bonus, payable Sept. 5.

†Coronation Syndicate.—3½ cents, payable Sept. 11.

***El Oro Mining and Exploration Co.**—2½%, payable Oct. 9.

***Exploration Co.**—2½%, payable Sept. 25.

†Geevor Tin Mines.—2s.

***Gopeng Consolidated.**—9d., payable Aug. 19.

***Idris Hydraulic Tin.**—4½d., payable Aug. 11.

***International Nickel Co. of Canada.**—Quarterly 40 cents, payable Sept. 20.

†Johannesburg Consolidated Investment Co.—35 cents, payable Sept. 15.

***Kent (F.M.S.) Tin Dredging.**—4½d., payable Sept. 18.

†Kentan Gold Areas.—1s. 6d., payable Sept. 29.

†Kinta Kellas Tin Dredging.—15%, payable Oct. 2.

***Konongo Gold Mines.**—1d., payable Sept. 15.

***Mary Kathleen Uranium.**—2s. Aust., payable Aug. 24.

†Mason and Barry.—12½%.

†New Central Witwatersrand Areas.—3¾ cents, payable Aug. 28.

†Northern Rhodesia Co.—10% and 5% bonus.

Pahang Consolidated Co.—Pref. 3½%, payable July 31.

***Pengkalen.**—4½d., payable Aug. 18.

†Powell Duffryn.—10%, payable Oct. 3.

***Rambutan.**—3d., payable Sept. 1.

†Selukwe Gold Mining and Finance.—5%.

***Sungei Way Dredging.**—10%, payable Aug. 28.

***Tanjong Tin Dredging.**—6d., payable Aug. 26.

†Tehidy Minerals.—7½%.

***Tronoh Mines.**—2s., payable Sept. 6.

METAL PRICES

Aug. 9.

Aluminium, Antimony, and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	186	0	0
Antimony (Eng. 99%)	230	0	0
Chromium (98%–99%)		7	2½
Nickel (Home)	660	0	0
Platinum (Refined)	30	5	0
Silver		6	7¾
Gold	12	10	7
Wolfram (U.K.)		—	
(World)	6	10	0

Tin, Copper, Lead, Zinc — See Table, p. 108

Note on the Perimeter Blast

New explosives with closely-spaced holes provide clean break

Hugh G. Jarman

In recent years many new products and blasting techniques have been introduced and have led to greater efficiency as well as increased safety on many blasting operations both at surface and underground. One such new technique, called " Cushion Blasting," has been successfully and extensively employed on many projects to control overbreak on canal walls, foundation excavations, and permanent bench walls. This technique is based on closely-spaced holes for the outside row lightly loaded with " string " charges. It has shown to particular advantage where blasting in thinly-bedded sediments and in blocky fractured formations where

Fig. 1.— Pattern of Perimeter Holes for Slashing a Tunnel.

Fig. 2.—Individual Xactex Cartridges, 24 in. by $\frac{5}{8}$ in.

overbreak and unstable walls would result from standard blasting techniques.

The success of cushion blasting stimulated research into developing a similar method for underground operations, employing small-diameter drillholes, and intended to ease the problem of "loose." Chemists and explosive engineers have recently introduced such a method, together with a new and specially-formulated explosive designed for the purpose.

Perimeter blasting uses basically the same technique as that for cushion blasting. It consists of a carefully-drilled row of small-diameter holes on the outside—or perimeter—with a predetermined burden-spacing ratio, loading each with a very light continuous explosives charge, and then firing them simultaneously, so that the rock is cleanly sheared from one hole to the next. Best results are obtained when the outside row of holes is blasted to a free face, as in a slash, and fired simultaneously; in some instances, however, the perimeter holes are blasted along with the rest of the round with reasonable success.

The technique usually produces firm solid walls with traces of the drillholes still being visible. The small diameter "cushioned" charge produces a minimum of shock, minimizing overbreak and resulting in a major improvement in the condition of the back and walls. This reduces the hazards from rock falls due to "loose" and greatly lessens the need for scaling, at best a difficult and dangerous job. The consequent saving in set-up time can be used for production purposes.

Perimeter blasting is of great value in underground operations when cutting shaft stations, driving main haulage ways or tunnels, excavating rooms for workshops, crushers, hoists, or other types of permanent installations, where clean solid walls are of importance. In mining it can increase production per machine shaft in wide shrinkage or cut and fill stopes, silling-out operations or similar types of work, with decreased costs for rock bolting, timber support or other forms of roof control. Pillar lines can be cut more accurately with less damage to permanent walls, resulting in a reduction in sloughing and correspondingly stronger roof support.

In other underground operations the technique can provide smoother walls, which are a distinct advantage especially as it makes concreting of the rock face easier, safer, and less costly, where it is required.

Perimeter blasting merits and possibilities for use in underground mining in Canada, were first recognized there by the firm of

Fig. 3.—Coupling Lengths of Cartridge.

Fig. 4.—Results of a Perimeter Blast at Lamaque Gold Mines, Quebec.

A. D. Margison and Associates, Ltd., of Toronto, and their mining consultant Mr. P. S. Broadhurst. The original field testing was carried out by the Lamaque Mining Co., Ltd., at Bourlamaque, Quebec. During those tests it became evident that a number of factors were of paramount importance if best results were to be achieved :—

Accurate Drilling.—Results are dependent to a large degree upon the accuracy and care taken in drilling the perimeter holes. It is essential that they be properly lined up to keep the final contour of the excavation within the desired limits and leave the back and walls smooth and solid.

Proper alignment is naturally more important when the excavation is of a permanent nature, particularly when it is not to be concreted, as in many underground shaft stations, refuge rooms, etc. Even where concreting is planned it is obvious that a little extra care with hole alignment means better results and dollars saved in time and material. In stops or haulage drives accurate alignment of the perimeter holes means less scaling, less need for roof supports, less rock bolting, and a higher percentage of the shift available for production purposes together with safer working conditions.

Spacing Ratios for Burden.—To minimize the effect of the explosives on the walls of an excavation it is of great importance that the drillholes be positioned in such a manner that the rock to be broken is not too tightly "wedged." If the holes are tight they will naturally require heavier explosive charges than when they can break to an established face. For best results the drilling off of the entire round as well as the detonating sequence of the individual holes must be carefully planned so that the rock is blasted away progressively towards relatively "free" faces.

Spacing to burden of the perimeter holes should normally be kept in the ratio of 0·8 to 1, the preferred pattern being 2 ft. spacing to 2½ ft. burden. This pattern, when combined with simultaneous firing of the perimeter holes, will provide the necessary shearing action ; certain ground conditions, however, may require that the spacing/burden ratio be modified for optimum results. The principle involved is that the ratio should be such as to induce breakage along the place of the drillholes rather than to have each hole break through its own burden to the free face.

The hole diameter does not seem to be a critical factor and holes from 1¼ in. up to 2½ in. have been used with equal success on the same drilling pattern and with identical explosive loads.

Loading the Charge.—The perimeter holes are loaded by two distinct methods, which are employed according to whether the holes

are being blasted to a free face or together with the rest of the round. Care is required to load the holes with either method.

When slashing to a free face one stick of explosive is normally used (Forcite 40% 1 in. by 8 in.) primed with an electric detonator and placed in the hole. This charge, in addition to acting as a primer, is required to provide the extra energy needed in the bottom of the hole to avoid bootlegs. In the "tight" corner holes additional cartridges of the regular size explosive may also be required. The primer is then pushed to the bottom with the Xactex column (a C.I.L. "Slender Stick" explosive made with a collar on one end so thay can be joined together to fit the hole depth). This ensures that the Xactex column is in direct contact with the primer, which is very necessary for proper detonation. The hole must be well stemmed with clay, which is of vital importance to confine the explosive gases and thus obtain the required shearing action from hole to hole.

When Xactex is used to blast the perimeter holes in a drive or tunnel along with the rest of the round the toes of the holes should be loaded with at least two cartridges of the normal size explosives. In the "tight" corners three or four cartridges may be required to provide the extra energy needed. The cartridges of normal explosives can be pushed to the bottom of the hole with the special explosive column.

Firing Methods.—For best shearing action and minimum shattering of the new rock face the row of perimeter holes should fire simultaneously and break to what is essentially a "free" face. The preferred method is to blast out the main part of the round in a preliminary operation leaving the perimeter holes to be loaded and blasted separately. In such cases the perimeter holes can be initiated by instantaneous electric blasting caps.

On the other hand, where the perimeter holes are part of a round, or are to be blasted with a preceding row or rows of holes, the perimeter charges of necessity must then be initiated by short-period caps, or even with safety fuse and blasting caps. The perimeter holes should in all cases be fired as near to simultaneously as is possible but at a later interval than the main part of the round.

The firing interval chosen must be of sufficient order to permit the main part of the round to move out before the perimeter holes are initiated, so that the relief of the burden on the latter holes will minimize the backbreak or shattering of the finished walls. The corner holes may be delayed by a further period after the perimeter holes to take care of the tight conditions that normally exist in such locations.

Wherever perimeter blasting has been used traces of the back holes have been evident in all the rounds. In those cases, where competent rock was encountered, all the back holes could be seen for their entire length. Under ideal conditions use of this technique can make the final contour appear almost as if it had been carved out of rock.

Developments in Titanium

M. Schofield, M.A., B.Sc., F.R.I.C.

A note on the history of an important metal and of current industrial uses.

The element titanium commands special interest in these days, with the large-scale sodium reduction process of Imperial Chemical Industries in mind, together with the considerable developments in forming the metal at Witton and Waunarlwydd. These considerations are all so topical since titanium was first discovered by a Cornish clergyman, William Gregor, who was born 200 years ago. Britain, the United States, and Japan have assumed the role of titanium metal producers, although the element is

widely distributed and has long been known to industry as the incomparable white pigment, titanium dioxide. Demands for titanium in the aircraft industry caused a vigorous expansion in production of the new metal and although a recession came in that industry titanium made up the set-back by adoption in chemical engineering as a metal superior to stainless steels in resisting corrosion by acids and chlorine derivatives.

Since this year, as already noted, brings Gregor's bicentenary, the discovery and arduous efforts to harness titanium metal merit reference, especially since no other metal proved more intractable because of its high affinity towards oxygen, nitrogen, carbon, and hydrogen, a property which caused pure titanium to remain unknown for decades. The black beach sands of weathered titanium-bearing rocks, which still constitute an invaluable source of the element, serve to remind us how Gregor noted black rutile sand by the Menachan stream in his Cornish parish, saw something new therein, and later described in Crell's *Annalen* how he prepared from the sand a reddish-brown calx or oxide of a new element.

Although Gregor suggested " menachanite " as a name for the element present in his new base that name was soon forgotten when Martin Klaproth, a brilliant German analyst, found in a red schorl an oxide which closely resembled the " iron-shot " mineral of " M'Gregor of Cornwall ". Klaproth on one occasion changed " glucinum " to " beryllium " as more appropriate and so with the new element, not yet liberated but recognized as a new base in chemistry, he renamed it : " I shall borrow the name from mythology, from the Titans, the first sons of the earth. I shall call this new metallic genus Titanium."

The oxide was studied, the reactions of titanium in solution recorded, yet throughout years of endeavour on the part of eminent chemists in Europe the metal itself proved a problem, with its wayward tendency to combine with other elements and with gases in particular. There was a hint of titanium appearing in slags when the chemist Wollaston, father of powder metallurgy, thought he had extracted tiny crystals of the metal from a slag from Merthyr Tydfil, but Wöhler showed these to be titanium nitride, a compound to become well-known to those who attempted to prepare the metal in an atmosphere not nitrogen-free.

A first sample of impure titanium came in that great period in which the alkali metals potassium and sodium were used as reducing agents, a phase in which Deville produced metallic aluminium and magnesium. Berzelius obtained a black metallic powder when he used his favourite potassium metal reacting with a double fluoride of titanium and potassium, the metal being far from pure. Deville and Wöhler tried reduction of the double fluoride by potassium in a hydrogen atmosphere, although once again the grey metal powder was crude and contained some titanium nitride. At the end of last century Moissan was succeeding in experiments to prepare several rare metals by the use of his recently-discovered electric furnace, this being a simple cavity within a limestone block and holding two carbon electrodes. Moissan succeeded with molybdenum, vanadium, and other less-common metals, yet his titanium included 2% carbon.

It was in returning to the sodium reduction technique that a first successful production of the pure metal was attained—this in America following the work of Nilson and Petterson in Sweden. These two Swedish chemists had tried sodium for reduction within a steel cylinder, but the titanium produced had sodium monoxide as one impurity and was only 95% metal. Yet this " bomb " process, using sodium, at last yielded the first pure titanium for study half a century ago, when M. A. Hunter first tried reduction with potassium, then lamp-black and the inclusion of titanium oxide to react with any combined carbon, and finally sodium. In a steel vessel capable of withstanding 40,000 kg. per sq. cm. pressure, with a lid held by six braces and rendered gas-tight with a soft copper gasket, Hunter not only produced the first titanium for examination of its physical properties but opened the way to sodium reduction on a large scale. Reduction with sodium had begun the extraction of aluminium and magnesium in a previous century ; now it was the turn of titanium, although on this occasion the process was to expand to become in modern industry a rival to magnesium reduction.

Before reviewing the rapid rise in titanium production and applications the prospects for its minerals or resources may briefly be summarized. The element or metal was dubbed " rare " in the past only because of difficulties in extraction now overcome.

Listed as ninth element in order of abundance, titanium is widely distributed in almost all rocks, sands, clays, as well as in coals, oils, and dredged marine samples. Yet only two sources are important, the first being ilmenite, a titanium-iron oxide, and the second rutile or TiO_2. The former contains $FeTiO_3$ or true ilmenite, the ore being better styled ilmenite-magnetite or titanomagnetite when iron or magnetite is high. Ilmenite and rutile are found in igneous, metamorphic, and sedimentary rocks, both being well-known in the black sands of beaches and rivers. These sands became prominent as sources of titanium which had been concentrated by weathering and, although rutile sands from the Far East, Australia, and Florida are still important, in recent years the emphasis has been on new massive ilmenite rock deposits averaging 30% TiO_2, especially since the older titanium pigment industry calls for ever-increasing tonnages.

By now the annual production of ilmenite is of the order of 1,700,000 long tons and of rutile, 100,000 tons, the latter figure being in contrast to less than 7,000 tons only 20 years ago. Rutile has been the sole source of titanium tetrachloride for producing the metal owing to problems associated with the high iron content of ilmenite, but with such rapid increase in metal production it has been found necessary to work up ilmenite to the chloride. The western hemisphere acquired new vast resources of titanium with the discovery of hundreds of millions of tons of ilmenite at Allard Lake in Quebec. Large tonnages are now shipped by the Quebec Iron and Titanium Corporation to Sorel for reduction to iron and a rich titanium-bearing slag. The idea of selective reduction with possibly a modified blast-furnace technique had been studied in Canada and Japan, but although first results with an arc furnace at Sorel gave a slag with over 70% TiO_2, this was only suitable for pigment production. Japanese claims are for a slag containing over 90% of titanium dioxide.

Turning now to the intensive work put into titanium production since Hunter made the first pure metal half a century ago, the reduction of $TiCl_4$ by magnesium or sodium began in 1940 with W. J. Kroll's classic paper in the *Transactions* of the Electrochemical Society for that year. Reduction of titanium oxide by carbon in an electric-arc furnace gave impure metal with much carbide or carbonitride present, while even calcium metal which yielded some ductile titanium became ruled out since nitrogen-free titanium was the target. In contrast is $TiCl_4$, a liquid easily purified and controlled, one readily reduced by molten magnesium and forming as by-product magnesium chloride from which magnesium and chloride are readily regenerated by electrolysis. The reaction between $TiCl_4$ is violent, so much so that in early trials the magnesium bath boiled up and magnesium vapour met incoming chloride vapour in a red-hot feed pipe. However control is now complete, even though no continuous Kroll process is in sight.

The magnesium reduction process as developed by the U.S. Bureau of Mines used argon as inert atmosphere in the reaction vessel of steel, with excess magnesium essential to avoid formation of a lower titanium chloride causing trouble in the product. The exothermic reaction sets in as titanium chloride is fed to the molten magnesium layer, some external heating being required first to melt the magnesium and later to maintain the reaction when it has slowed down. To recover titanium sponge from the mass left, which is magnesium chloride *plus* excess magnesium admixed with the product, Kroll first tried a leaching process using dilute hydrochloric acid. (Much of the magnesium chloride is tapped off during the reduction.) Leaching gave way to a high-temperature vacuum distillation of the above residues to leave titanium within the vessel, the metal sponge being then crushed in readiness for arc-melting or induction melting to titanium ingots.

As a rival to magnesium reduction of titanium chloride came the sodium reduction process first worked on a commercial scale by the Degussa concern in Germany during World War II. Kroll and his co-workers discussed in 1950 the relative merits of magnesium and sodium in titanium production, this before sodium became the cheapest non-ferrous metal on the market. It was pointed out that a greater bulk of sodium was required and a larger mass of salt is left within the reaction vessel, since sodium chloride could less readily be removed. The low boiling point of sodium (880° C.) and the high melting point of sodium chloride (801° C.) demanded a smaller range of operation temperature, since sodium must not be permitted to vaporize. On the other hand, the low boiling point of sodium meant that excess could readily be removed in the vacuum distillation operation.

With sodium so readily available at low cost I.C.I. began a sodium process at Wilton after work on the magnesium method, a first batch process yielding only 7 lb. of titanium from each reactor developing to modern sodium reduction with batches from 1 ton to 2 tons of metal. (The only other large-scale sodium reduction process is operated by the Electrometallurgical Division of Union Carbide, in Ohio.) The steel reactor used in the British version is heated by oil-firing, although the vigorous exothermic reaction provides most of the heat to maintain the vessel above the melting point of the fused salt. Argon is the inert gas used and, after the charge of pure sodium has been taken to about 700° C., the $TiCl_4$ feed is begun.

In contrast to the Kroll magnesium method excess of reducing metal is to be avoided, since much sodium would obviously be a danger in subsequent leaching operations to recover titanium sponge. Several days have to elapse before the reactor is cool enough to be opened for leaching the mass, this leaching involving the use of dilute acid. Although this sodium reduction process has been developed to high efficiency no continuous production of titanium has been attained as yet.

Other possible methods of titanium extraction have attracted considerable attention; these include Van Arkel's "hot filament" dissociation of titanium iodide within an evacuated vessel to yield the purest titanium known, yet one hardly economic for the thousands of tons titanium metal envisaged within the next year or two. Reduction of titanium oxide by magnesium and calcium has also drawn much study, as have electrolytic methods; yet the sodium and magnesium reduction processes hold the field.

Despite this limited scope in producing titanium, which still costs several pounds per pound weight, vigorous developments have appeared in the titanium industry as regards arc-melting furnaces, forming techniques, and an ever-increasing application of the metal in chemical engineering. Vacuum melting of titanium has resulted in improved properties and removal of gaseous traces, particularly hydrogen, the modern consumable-electrode furnace being a highly-efficient unit dealing with ingots weighing 2 tons. By compressing titanium in steel dies and welding to an electrode, with up to 25,000 amps. melting current and electrodes fixed to a water-cooled ram passing through a vacuum seal at the top of the furnace, all problems seem to have been solved. In 1958 the largest melting-furnace in Europe was set up at the Witton works of I.C.I. for producing double-melted ingots of up to 4,200 lb., titanium ingots from such furnaces being of homogenous nature and of high quality.

Apart from melting and forging at Witton, the fabrication of titanium at Waunarlwydd illustrates how British, as well as American, interests have advanced the metallurgy. Five-in. to 6-in. billets from Witton are electrically-heated and hot-rolled down to the required size, while also at Waunarlwydd are units for working rolled round bar and rod and for producing several hundred tons annually of such products as titanium sheet. Titanium is not only available in rod, wire, sheet, or seamless tubing, but in various grades from "soft" titanium or more ductile metal for lining chemical plant, to a harder metal for use in forging, controlled small additions of TiO_2 enabling this modification in physical properties.

In contrast to some pessimism regarding the rôle of titanium in aircraft, applications of the metal in chemical plant are undergoing considerable developments. Here is a metal half as heavy as steel, looking like mild steel, yet with high resistance towards forms of chemical corrosion which are too much for stainless steels. It is immune to brine, chloride solutions, sodium hypochlorite, chromic acid, concentrated nitric acid, sulphides, hydrochloric acid, and free chlorine. Its resistance to salt water is significant, sea-spray being of no more effect than seen in the platinum metals. Pumps for handling 99·8% nitric acid at an I.C.I. works have been found to have a longer life than in the case of niobium stainless steel, a titanium pump having already given 7,000 hours service without signs of trouble. Lead-lined steel for acid-chrome plating baths is inferior to titanium linings. In the bleaching industry the metal is a boon in being completely resistant to boiling solutions of chlorite or hypochlorite of sodium and to hot chlorine oxide vapours evolved from bleach baths. In the paper-pulp industry heat exchangers and reaction vessels for producing chlorine dioxide bleach are of titanium or titanium-lined type, while valves, fans, pumps, and tanks are also of resistant titanium for handling hypochlorite and wet chlorine liquors.

Shipping Sulphur in Liquid Form

J. Grindrod

A technique devised by the Freeport Sulphur Company is described

Until recently the sulphur mined by the Freeport Sulphur Company in the Gulf of Mexico area by the Frasch hot-water process, has been brought to the surface in molten form at a temperature of about 300° F., sprayed into vats, allowed to solidify, and then broken up and shipped in solid lump form as a dry commodity. Lately, however, there has been a strong and growing preference among the company's sulphur customers for deliveries in liquid form and to meet this demand Freeport has begun to operate an extensive programme of liquid sulphur shipments into major market areas for storage and trans-shipment to its customers. Plans, in fact, call for facilities capable of handling about 1,500,000 tons a year in this way. This represents well over one-half of the company's current annual sales.

Included in the programme are new liquid storage terminals on the inland waterways served by special barges up the Mississippi, Illinois, and Ohio rivers, as well as other terminals in Florida and on the Atlantic coast served by tanker. Shipments up-river began late last year and coastwise shipments were inaugurated in February this year. So far no exports are being made of sulphur in this form, but the changeover in the domestic market is said by Freeport to be growing rapidly.

Being independently financed by marine transportation and terminal companies, the new marine equipment and terminal facilities are ultimately expected to cost about $20,000,000. They are to be operated under long-term contracts with Freeport, who are providing additional facilities costing between $3,000,000 and $4,000,000. These figures do

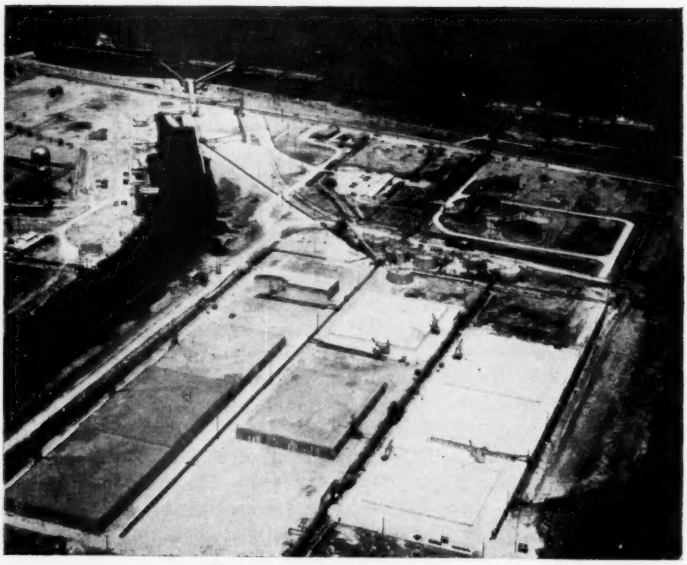


Fig. 1.— Port Sulphur, Louisiana : Storage and shipping point on the Missouri River.

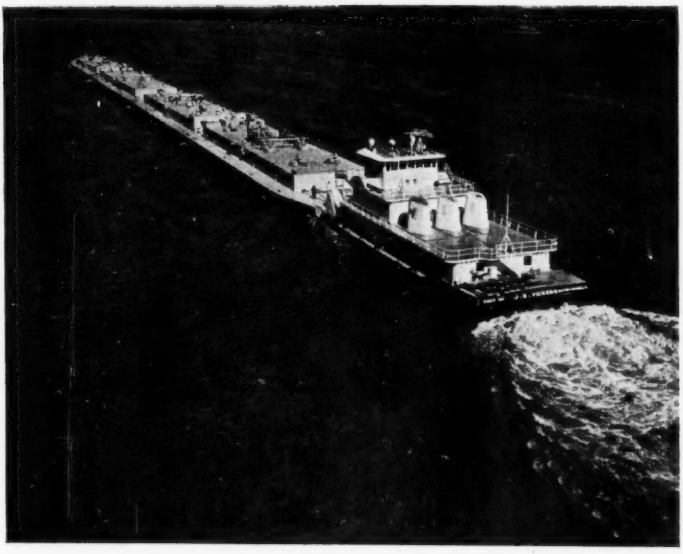


Fig. 2.—High-Speed Tow for Liquid Sulphur Barges.

not include expenditure by consumers for their tanks and facilities.

The new method of delivery will, it is claimed, give lower plant handling costs and eliminate problems of loss in handling, which normally average one-half per cent., of contamination from moisture, scale, and other foreign solids, and of dust, which causes deterioration of plant equipment.

Fig. 3.—Loading at Port Sulphur.

At the two up-river terminals storage capacities of 30,000 tons and 20,000 tons respectively should ensure continuity of supply under adverse water or weather conditions. Highly-automated reloading facilities will serve both tank trucks and railway wagons and development plans include provisions for expansion at each base terminal and the addition of new terminals as market conditions warrant these. These terminals will supply the major American sulphur-consuming areas, including the States of Illinois, Indiana, Michigan, and Wisconsin from the Joliet, Illinois, terminal and Ohio, western New York State, and Pennsylvania from Wellsville, Ohio. Both terminals will also serve plants in Ontario, Canada, up to 800 miles away. From the shipping port of Port Sulphur, Louisiana, the river trip to Joliet is about 1,400 miles and to Wellsville about 1,900 miles.

For the coastwise shipments terminals are located at Tampa, Florida, Everett, near Boston, Mass., and Bucksport, Maine. Tampa will serve the greatest sulphur-consuming area in the United States, the annual demand there being about 700,000 tons chiefly for the production of triplesuperphosphate fertilisers.

New storage and loading facilities at Port Sulphur include four new 9,000-ton tanks, to bring the liquid storage capacity there to

almost 60,000 tons, and a new ship-loading tower. At the same time Freeport is to continue its already existing barge service for supplying liquid sulphur direct to customer plants on the inland waterways in Alabama, Arkansas, Mississippi, and Missouri.

Stone for Asphalt Roofing

Specialized work at an American plant is described

A. E. Williams, Ph.D., F.C.S.

Crushed stone is used in asphalt roofing material to impart mechanical strength and to prevent the material adhering together when in the form of rolls, the stone being attached to the binder during manufacture. While some of this material is produced in its natural black state—due to the asphalt—much of it is manufactured in attractive shades, the latter being obtained by the addition of colours to the stone.

A typical American company engaged in the manufacture of asphalt roofing is the Funkhouser Division of the Ruberoid Company, of Hagerstown, Maryland. At this plant (Figs. 1 and 2) stone is crushed at rates of 10 tons to 20 tons an hour around the clock, six days a week, seven months a year, and on one or two shifts during the other five months. This is a rugged assignment for any crushing plant, but when a company is supplying the asphalt roofing industry these rates simply have to be met when the busy building season comes along.

The crushers employed for this task are made by Sturtevant Mill Company, of Dorchester, Massachusetts, and are of the balanced-roll type. They manufacture automatically adjustable rolls in sizes ranging from 8 in. by 5 in. to 36 in. by 20 in. The largest-size rolls will receive as feed material 3-in. pieces and finer and discharge at the rate of up to 87 tons per hour. These rolls are also effective in reducing materials when a minimum of fines is desired and may be employed to produce varying sizes of minerals, depending on the setting of the rolls, with the

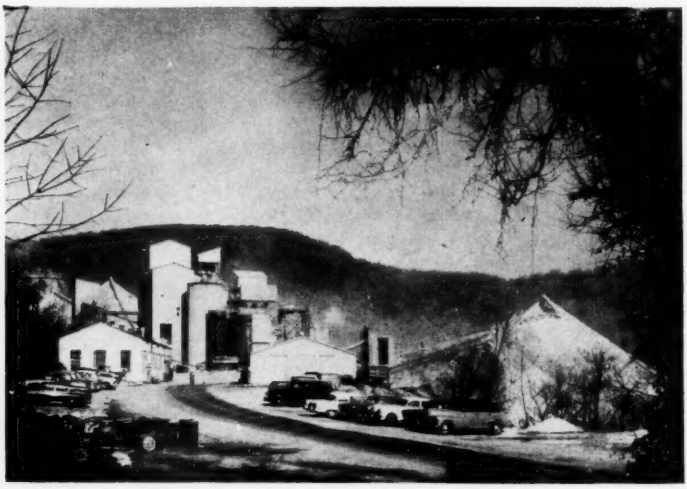


Fig. 1.—General View of Plant at Hagerstown.

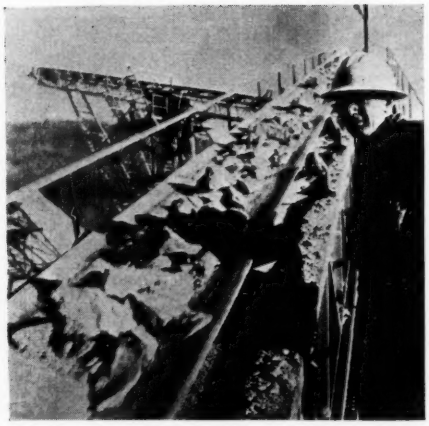


Fig. 2.—Elevating Stone to the Crusher House.

finest settings at about 20-mesh. At the Funkhouser plant use is made of six 30-in. by 16-in. balanced rolls in two groupings of three—one coarse pre-grind, the remainder fine grind. Of these six units three have been in this exacting service for 32 years.

The three rolls which were put in in 1928 proved themselves to be extremely rugged, so much so that the next units required were in 1955. At that time three Sturtevant 26-in. by 15-in. rolls were purchased, from a used equipment dealer, for supplemental operations. They did not replace the earlier crushers. However, when production had to be increased substantially in 1958 the Funkhouser company sold one of the smaller rolls and put in a re-order to Sturtevant for one 30-in. by 16-in. unit. In 1959 two more were ordered and installed and the present groupings were arranged (Fig. 3). The coarse pre-grinding units take the stone and reduce it to about $\frac{1}{4}$-in. pieces (Fig. 4) ; this material is then further reduced in the fine-grinding stage. The resultant granules are sold generally in carload lots to the asphalt roofing industry, but some are bagged. Depending upon requirements the granules may be coloured to meet specifications.

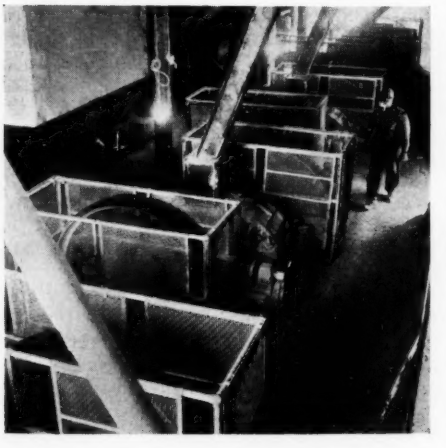


Fig. 3.—Batteries of Crusher Rolls.
There are six units in operation.

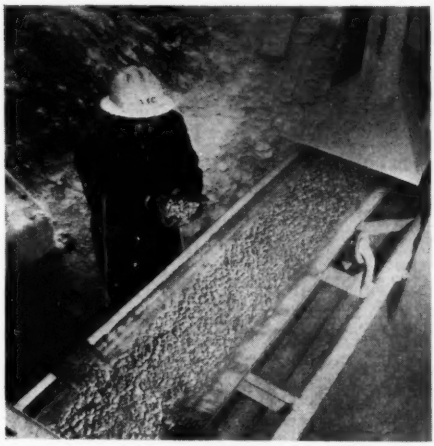


Fig. 4.—Crushed Stone under Inspection.

Funkhouser's process is exactly like that of most other crushed stone quarries except for the addition of the balanced rolls and the coloration of the end product. The quarried stone is crushed in a primary jaw-crusher before undergoing further crushing. Dry cone-crushers bring it down to about $\frac{5}{8}$-in. pieces, which form the feed for the balanced rolls, and the latter have always played an essential part in the production of the stone for the asphalt roofing industry. In over three decades of operation the Funkhouser management has always found the balanced roll units to be easily accessible for adjustment and maintenance. The only adjustment needed on the six mills has been the replacement of tyres when these wear down under the erosive action of the stone. These replacements are carried out when the tyres are down to $\frac{1}{2}$ in.

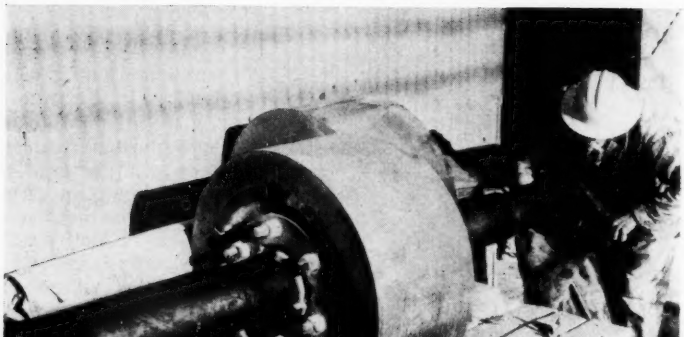


Fig. 2.— Roll Tyre Interchange in Progress.

or $\frac{5}{8}$ in. At the same time the bearings are changed, although these rarely show any appreciable wear. This precautionary maintenance step has saved downtime and has kept the units trouble-free. Total downtime for tyre interchange is one shift—four men—once every two or three months for the coarse grinders and once every four or more months for the fine-grinding mills (Fig. 5). Tyre change is effected by removing the old parts with an electric hoist and dropping the new ones in place. Then the flywheels, or pulleys, are replaced and the unit is ready again for production. As all the parts are interchangeable irrespective of age of the unit only a minimum of parts has to be kept in stock.

Ore-Dressing Notes

(4) *Production*

Israeli Phosphates

Negev Phosphates, Ltd., commenced production in 1952, the main handicap at that time being the lack of water, with the nearest producing well ten miles distant. Only dry processes were considered in the initial stages and one which yielded a 28½% concentrate of P_2O_5 was developed. The ore is of the general formula $Ca_3(PO_4)_2.CaF_2$ and occurs as oolitic particles sized between 35 *mesh* and 200 *mesh*, cemented by calcite. There are two phosphate beds, separated by strata of chert and calcite which are brought out with the ore in open-pit extraction. Dry concentration exploits the difference in hardness and breaking characteristics between the oolites, the cementing calcite, and the free chert and limestone. Large lumps of the latter are too low in phosphorus to repay treatment and are rejected. The balance is crushed to *minus* 4 in. and assays 23% P_2O_5. It is first dry-scrubbed and autogenously ground in a horizontal drum from which it emerged at *minus* 1½ in., this including a band of *minus* 28 *plus* 200 mesh phosphate of usable quality. Coarser and finer fractions are removed in cyclones and stockpiled for future treatment. The concentrate either goes 140 miles north to Haifa for processing to superphosphate or the same distance south to the Red Sea.

There is a huge reserve in the Negev area, but the grade produced by dry treatment is not of interest to the export market. From 1955 on the feasibility of wet concentration and the associated problem of water supply has been studied. The greatest need is for desliming. The oolites are liberated at about 35 mesh, at which grind there is some 40% of *minus* 400 mesh natural slime carrying some 18% P_2O_5 as calcareous clay which interferes

with concentration by coating the oolites and by consuming reagents. Efficient wet scrubbing is essential.

Preliminary study showed that flotation with a fatty-acid collector could be used to float off the calcite from the phosphate in a deslimed pulp. Conditioning, if prolonged, produced slimes and led to trial of the possibility of direct addition of collector and a short flotation time. Later it was found that naphthenic acid was more selective in floating calcite and gave a concentrate assaying up to 32% P_2O_5 with 87% recovery. Further than this only pulp temperature—best at 35° C.—and composition of water affected the process. Heating would, however, have been expensive, but further study led to the use of " kadimic " acid as a collector which would give a good deep froth and a reasonable recovery (80% at 31% P_2O_5). This reagent would not work with hard water such as that available, which contained up to 380 parts per million of HCO^-_3 ion, suspected to be the main interfering agent. Liming of the water to give a flotation pH of 10 neutralized this and reduced any interfering effect from metal ions present (Ca, Na, Mg). The effect of build-up of interfering ions was also studied, as the plant was to depend on reclaimed water. One curious discovery was that after three stages of recycling reclaimed water was better than fresh. As a result fresh water is now used for desliming and reclaimed water in the flotation circuit.

Feed to the wet plant could be run-of-mine coarse rejects from the dry plant or fine rejects. Initially the last-named is being treated in a 300 tons per day operation. There are three stages of desliming in cyclones followed by one-stage flotation, filtration, and drying.[1]

(5) *Jigging*

A Modified Diamond Jig

A recent paper by R. G. Weavind and D. F. C. McLachan[2] describes alterations made to the Denver jigs used at the Premier mine to treat a *minus* 2 mm. kimberlite feed at a high rate. Each of the eight primary jigs is fed at 20 tons hourly, which is much more than allowed for in the original design. To check efficiency of performance two methods were looked into :—First, the use of radioactive tracer diamonds prepared by cementing radioactive cobalt wire into a hole drilled in the selected gemstone and, secondly, adaptation of the Tromp curve used in coal testing, by plotting percentage recovery of, say, the hutch product against specific gravity of material recovered. Both methods were used to assess jig performance, preference being given to the radiotracer technique.

Feed to the 24 in. by 36 in. jigs is *minus* 9 mesh *plus* 28 mesh, tailings being discarded and hutch products re-treated in two secondary jigs from which the light fraction is recycled. The jig variables controlled were feed rate (20 tons hourly) ; entering moisture (25% *plus* that added to the hutches of the two compartments) ; bedding (steel shot later replaced by alluvial gravel) ; stroke frequency, and amplitude. Their effect on *minus* 10 *plus* 14 mesh flattish radioactive diamonds was observed. Since surging from the classifiers caused irregular feed to the jigs and scouring of the bed at the feed end, the first modification was a restraining plate 3 in. above the feed weir, behind which the entering material piled up and entered smoothly. Optimum flow of water was 11,500 gal. hourly with a ragging of steel shot and 9,500 gal. hourly with gravel. Since the rotating water valve restricted the flow rate to 7,600 gal. per hour this appliance was removed and separation accuracy benefited.

The diamondiferous fraction of kimberlite has a density of about 3½ and its associated minerals 2·7, which renders gravel of density 3·2 better than steel shot (7·2) as a bedding medium. This was sized to *minus* 10 *plus* 6 mm., with 130 lb. in each compartment, giving a bed thickness of 2 in. to 3 in. Its use gave a marked rise in efficiency. The final stroke frequency arrived at was 270 cycles per min. at which rate the optimum stroke amplitude was ½ in. Under these operating conditions 87% recovery was obtained on the test diamond. An octahedral diamond of *minus* 9 *plus* 10 mesh reported correctly all the time of its test. Tests showed the quantity of water flowing to the compartments was a critical factor and that a strong suction stroke was desirable. With increase of feed rate to above 20 tons per hour efficiency showed a marked decline.

(6) *Comminution*

Steel *v.* Pebbles in the Ball-Mill (Part 1)

The forums on crushing and grinding sponsored annually by the Canadian Institute

[1] HOFFMAN, I. and MAIACHER, B. C. *Min. Engg.*, May, 1961.

[2] *J. S. Afr. Inst. Min. Metall.*, Jan., 1961.

of Mining and Metallurgy never fail to produce practical discussions of value to mill men and that held in April, 1960, and reported this January,[1] was no exception. The points raised by the many contributors, together with their supporting figures on costs, throughput, and metallurgical results make awkward reading and still more difficult the writer's attempt at an adequate and connected summary, but it is worth tackling—not least because in reading the account of the proceedings he was forced to re-examine some of his ideas on the whole subject. In brief, pebble milling is staging a comeback and doing it on sound economical grounds. One also gets the impression that the technical justification of semi-autogenous grinding (defined as that in which the pebbles are selected from the ore itself) contains elements which have not in the past received adequate attention at research level.

Sixteen points are summarized in the preamble to this forum and these include impact *versus* attrition ; mill speed and size ; mill ratio of length to diameter and shape ; liner design and composition ; shape and composition of grinding media ; transition point from dry crushing to wet grinding and role of rod-mills ; pulp density in mill, grinding stages, and classification. Many decisions are based on local conditions, ore types, and tonnages handled and the personal likes and dislikes of those concerned in ordering and running the grinding plant further complicates the search for an ideal set of rules in the field of grinding. Any or all of the factors just listed may make small alterations to grinding costs (which must still be related to the overall effect on the recovery and grade). One dominant point to emerge from the discussions was that pebble milling gave an overall saving of from 15 cents to 30 cents per ton treated and that the possibilities of obtaining such a relatively large saving should be a matter of lively consideration in mill economics. The increase in automation during the past few years should help with the general problems which arise with a fast-wearing load of crushing bodies in the mills. Some practical matters are summarized in what follows.

Describing the conversion and expansion of Renabie, a gold plant which uses flotation and cyanidation, L. R. Hann starts with the need to reduce costs and raise tonnage of the very hard siliceous ore from its 1956 average of 419 tons per day to 550 tons per day. Pebble grinding was decided on, the cost before the partial conversion thus entailed averaging $0·756 per ton for crushing, grinding, and classification (about 50% of the total milling costs). Consumption of steel balls was then nearly 4 lb./ton, producing a 72% *minus* 200 mesh overflow. A rod-mill was installed between crusher product and pebble-mills, the crushing circuit being opened to $\frac{1}{2}$ in. discharge setting. Pebbles screened out in the crushing circuit are now discharged from their separate 70-ton bin into a weighing hopper and automatically fed into the mills. They are *minus* 3 in., *plus* $1\frac{3}{4}$ in., and replace $1\frac{1}{4}$ in. steel balls. Within a few days of start-up extraction in the cyanide section improved 3%, an effect ascribed to improved oxygenation. Capacity in the new plant comfortably handles the required 550 tons, but this is probably due in part to the increased grinding capacity rather than to any special virtues in the pebbles. Pebble consumption varies between 4% and 7% of the overall tonnage milled. Liner wear was heavy in the first year, due to several causes such as wrong liner design and the cost averaged 20 cents per ton milled. Double-wave liners are now used and wear has dropped to 14 cents per ton, less realization on worn scrap. Taking the rising cost of treatment at current figures the 1956 grinding section cost, then $0·75, would to-day be $0·83 per ton ; 1959 figures show a drop to $0·63, a saving of 20 cents, apart from the improved metallurgy also reported.

[1] *Canad. Min. Metall. Bull.*, Jan., 1961.

Sixth International Mineral Processing Congress

CANNES, 1963

The sixth International Mineral Processing Congress is to be held in Cannes from May 26 to June 1, 1963. Organization is in the hands of the Société de l'Industrie Minérale and the following executive committee has been appointed :—

President. M. R. J. Testut.
General Secretary. M. Pierre Gy.
Members. MM. Astier, Emery, Ploix, Rey, Saint-Guilhem, Saverot, Seyer, Vielledent, and Vuchot.

As in the past the Congress will be concerned with all aspects of mineral processing

and papers are to be selected entirely on the basis of their scientific and technical value. However, the Committee wish to place particular emphasis on the following subjects: (1) The concentration of iron minerals, including magnetic roasting but excluding agglomeration; (2) measurement, control, and automation, and (3) hydrometallurgy. Especial importance is also attached to the economic aspects of mineral processing and it is hoped that, whenever possible, authors will include data on installation and operating costs and comparative costs for alternative processes.

Scientists and engineers wishing to submit papers for the Congress should send a plan and a short summary of the intended subject matter together with a note on the original aspects and conclusions of the work to the representative for the United Kingdom and the Commonwealth, Professor M. G. Fleming, Royal School of Mines, Prince Consort Road, London, S.W. 7. This information must be received by October 15, 1961.

The official languages of the Congress will be French, English, Russian, and German. Papers may be presented in any of these languages and during the sessions the discussions will be simultaneously translated into the other three languages.

During the week following the working sessions at Cannes an extensive series of visits to mineral processing plants and laboratories in Mediterranean countries is to be arranged. These will include technical tours in France, Yugoslavia, Italy, Morocco, Spain, and Portugal.

Book Reviews

Bildkartei der Erzmikroskopie. By A. MAUCHER and G. REHWALD. Frankfurt/Main: Umschau-Verlag, 1961.

A start has been made in the publication of a card index of ore photomicrographs intended to cover all ore minerals. First-class polished sections will be illustrated and the total number of cards is estimated to reach 1,000. The first set of 104 cards has already appeared; later sets will be published at quarterly intervals.

The cards now available cover a variety of general aspects. Instructive photomicrographs of excellent quality illustrate the problems of sample preparation—pitting, imperfect grinding, polishing, and the effects of cleavage. A number of typical textures (as fibrous, cellular, filiform, cataclastic, crusts, rims) are surveyed. Sets of cards on native iron, argentopyrite, the valleriite-pentlandite parageneses, and the Corbach and Marienberg ore deposits of Germany are included.

The entire index is to be arranged in three parts: Section A, general topics, is to deal with sample preparation and preservation, as well as with morphological, mechanical, and optical properties of ore minerals. Section B gives a systematic survey of ore minerals, following Dana's "System of Mineralogy," and illustrates examples from typical parageneses and typical ore deposits. Section C deals with the technical application of ore microscopy, especially in ore dressing and metallurgy.

The publication of cards is to proceed generally according to the scheme given, but occasionally cards of other sections may be included. Each card is printed on one side only. The upper half contains either a single photomicrograph (110 mm. × 170 mm.) or a pair, each measuring 110 mm. × 83 mm., of the same specimen under plane polarized light and crossed nicols. The lower half consists of tabulated data on locality and photographic details and a brief explanation in English, French, Spanish, Russian, and German. Groups of cards under the same headline ("cataclastic texture," "native iron," etc.) are accompanied by a text card with more detailed descriptions of the sections in German and English. The price is 0·75 DM per photo-card and 0·45 DM per text-card. A reduction of 10% is allowed for university departments and academic staff and 15% for students.

The card index is of great value for professional ore-microscopists as a first-class reference work and for academic staff in teaching. However, the applications of the card index are by no means restricted to these fields. Economic geologists, mineralogists, and ore-dressing workers, as well as metallurgists, will find the index an easy-to-use, clearly written, and supremely illustrated collection of data on the ore minerals which are so often essential to their work. Research workers and technologists will appreciate the clear, down-to-earth, descriptive approach of the cards, uncluttered by theoretical mineralogy, genetical hypotheses, or specialist terminology. The card index will, no doubt, help those who find difficulties in applying

ore-microscopic techniques to the solution of their problems, be they concerned with drill cores or flotation concentrates.

The authors can be sure of the gratitude of everyone investigating ore minerals in reflected light for the first part of a very fine piece of work. No doubt this excellent multilingual publication will soon find the world-wide distribution it deserves.

S. E. HOLLINGWORTH.

The Geology of the Northern Rhodesian Copperbelt. Edited by F. MENDELSOHN. Cloth, octavo, 523 pages, illustrated. Price 84s. London : Macdonald and Co. (Publishers), Ltd.

This handsome volume, edited by the Chief Geologist to Roan Antelope Copper Mines, Ltd., is the first comprehensive account of the great mineralized strata in Northern Rhodesia which support the vast copper-mining industry in the Central African Federation. Prepared so as to be available for the Seventh Commonwealth Mining and Metallurgical Congress its contents were contributed mainly by the geological staffs of the mines and the service sections of the two chief operating groups—Rhodesian Selection Trust and the Anglo American Corporation of South Africa. The work provides in Part I a detailed description of the area, its location, geomorphology, geology, and structure, going on to discuss its metamorphic history and the ore deposits discovered. There follows a review of the various theories put forward to explain the ore genesis and then an account of the long history of exploration in the region. Part 2 contains a series of chapters each concerned with a particular area and a number of appendixes dealing with rock and mineral analyses, the history of the various mines, Copperbelt vegetation, and a very full bibliography. There is also a comprehensive index.

Genetic problems in the area have aroused much controversy, syngeneticists and those favouring an epigenetic origin still being strenuously opposed. If the syngenetic explanations seem at times over emphasized, the epigenetic theories still get a good airing. The exposition of opposing views can only lead in time to greater understanding, however, and the volume will be welcomed by all interested in the future of mineral exploration.

☛ Copies of the books, etc., mentioned under the heading " Book Reviews " can be obtained through the Technical Bookshop of *The Mining Magazine*, 482 Salisbury House, London, E.C 2.

Letter to the Editor

The Witwatersrand Controversy

Sir,—Scotch reviewers, according to Byron, have " just enough of learning to misquote." Professor Ramdohr concurs in this opinion. Twice in three years I have been accused of wilfully indulging in misquotation, mistranslation, and misrepresentation. On the last occasion I contented myself with recording that my so-called mistranslation was the work of an independent Government agency, on public file in London, and that collation of the English and German texts showed the imputations to be quite unfounded (*Economic Geology*, 1958, pp. 620, 1048). This time (THE MINING MAGAZINE, July, 1961, pp. 18–21) I cannot refute the allegations, now extended to " dozens, if not hundreds " of cases of misrepresentation and " hundreds of misquotations and wrong conclusions," since no specific example is given.

I have never misquoted Professor Ramdohr wittingly. If the diffuseness of his writings has led me in any instance—*I know of none*—to do so unwittingly, this is in part his own fault. Even so, it is not a matter of moment, for the issue between us is crystal clear. He claims that the uraninite particles in the banket are detrital, unmodified in shape and size by the geological events of two milliard years. I believe I have demonstrated, by unrefuted logic, that this contention cannot be sustained. Our readers are the jury, and in reaching a verdict they will doubtless consider not only the evidence but also the demeanour of the advocates.

In Professor Ramdohr's *apologia* he lists " a few points which represent a strong attack " on him. In no case does he admit an error. To err is human. *Es irrt der Mensch so lang' er strebt.* Regrettably, he prefers to respond with untruths and half-truths which, in the circumstances, I have no option but to expose.

First, in answer to my comment on irregularities in the dating of his memoir to the Berlin Academy, *vorgelegt von Hrn. Ramdohr in der Gesamtsitzung vom 24. Januar 1957 : zum Druck genehmigt am gleichen Tage*, he tells us that the year is a " misprint "—1957 should be 1958. There is no misprint. Reference to the *Jahrbuch* of the Academy shows that Professor Ramdohr did present a paper on uraniferous conglomerates on January 24, 1957, but no paper at all in 1958. It is clear beyond all doubt that he

withdrew the paper initially presented so that he could incorporate the results of later publications, sent a revised version to the Press not before April, 1958, and published it in November, 1958, with a spurious January, 1957, date-line. This surprising impropriety certainly cannot be blamed on the printer.

Second, self-deceived by this behaviour, Professor Ramdohr complains that I have accused him unjustifiably of neglecting to cite relevant works on geochronology which, he avers, were not published until one or two years after his memoir appeared. A paper by Nicolaysen and others is referred to as an example. The complaint is groundless. A summary of the results of this and related work was issued by the Geological Society of South Africa on January 21, 1958, and Professor Ramdohr, as a member of the Society, received a copy at once, more than two months before the real date on which his memoir went to press. The work was mentioned by me in a letter to *Economic Geology* dated July 15, 1958, which appeared in the November issue. The full text of Nicolaysen's paper was received in Britain by members of the Society six months prior to the delivery of copies of Professor Ramdohr's memoir.

Third, we are informed that I have attempted to teach Professor Ramdohr what the German term *Geröll* means, in the field of sedimentary petrology, " by reference to a Russian text-book." This is not true. The authority quoted, chosen out of many concordant works solely because it is the most recent, is a Government-sponsored German translation of a Russian text-book, checked for scientific accuracy by a German academician who is Professor Ramdohr's successor in Heidelberg.

Fourth, with respect to the so-called " Pronto reaction," we are told that :—

> The reaction $2TiO_2 + UO_2 \rightarrow UTi_2O_6$ takes place readily and completely when a flux is used. My pupil, Ö. Öztunali, published our findings in an easily accessible journal prior to Kaiman's paper. Dr. Davidson could have synthesized brannerite within 24 hours using our procedure. Using fluxes we have obtained the reaction down to 400° C. and it certainly takes place at lower temperatures.

On this I would comment : (*a*) I did not know of Öztunali's paper till recently, there being but one copy of the journal in Scotland ; (*b*) the priority over Kaiman is a matter of six weeks ; and (*c*) the only relevant part of this two-page crystallographical paper amounts to three lines, stating that the synthetic brannerite was formed by heating its component oxides in a mixture of sodium and potassium chlorides, within an evacuated quartz bomb, for 50 hours, to a temperature of 1,000° C. Professor Ramdohr can no doubt whistle up evacuated conditions and chloride fluxes in nature as readily as his other *dei ex machina*, but I prefer to maintain a logical basis for geological arguments. The new, undocumented, claim that brannerite can be synthesized at low temperatures using a chloride flux is not endorsed by Patchett and Nuffield (*Canadian Mineralogist*, 1960, p. 483) who find, in similar studies, that :—

> The flux reacted with the mixture producing a compound, possibly a sodium uranium oxide, whose major diffraction data showed some similarity to those of brannerite. The experiments confirm that brannerite is not synthesized under ordinary ignition conditions.

In any case this is all somewhat inapposite, since Professor Ramdohr makes no attempt whatever to contradict my demonstration that the uraninite-rutile-brannerite association can be paralleled in a great many hydrothermal deposits, of which still more examples could now be adduced.

Fifth, in an excursion into a non-oxidizing atmosphere various authorities are quoted in support of the view that uniformitarian principles " cannot be applied to the very oldest times." The quotations are irresponsibly irrelevant. Professor Ramdohr is well aware that the Witwatersrand deposits belong not to " the very oldest times " but to a period at least half-way through the earth's history.

Sixth, it is said that the various occurrences of spherulitic uraninite from hydrothermal formations which I have likened to the Witwatersrand mineral can be seen to be replacements of pyrite bacteria or very primitive fungi. It suffices to comment that, with one exception, the habitat of these reputed organisms is that of hydrothermal veins around granite stocks where the spherules form inclusions in rammelsbergite, clausthallite, and quartz, barytes, calcite, and hydrohaematite veinstuffs. The " organic structures " are thus demonstrably psychogenetic.

Seventh, a repetition of the bald statement that pyrite is roasted to pyrrhotite in contact

metamorphism by Ventersdorp lavas ignores my contention that researches at the Geophysical Laboratory on the pyrite-pyrrhotite inversion make the validity of this claim very far from *absolut sicher* or *völlig eindeutig*. Professor Ramdohr, writing from the Geophysical Laboratory, could readily have obtained an authoritative assessment of the accuracy of my argument. Astonishingly, he has refrained from doing so.

Eighth, it is alleged that I doubt Professor Ramdohr's much-repeated claim to have found uraninite in Witwatersrand ores (now plural !) as early as 1928. I have not said so. My statement is that it is difficult to correlate this claim with a failure to record uraninite in his descriptions of banket ores and Witwatersrand " carbon " published as late as 1950, in a text-book which mentions then unrecorded uraninite occurrences of no economic significance, such as Riddarhyttan. Whether the claim is *un esprit d'escalier* or not can be of no interest to anyone save Professor Ramdohr.

C. F. DAVIDSON.

UNIVERSITY OF ST. ANDREWS,
SCOTLAND.

July 24, 1961.

Engineering Log

In a recent paper C. P. Linsell describes the methods used to train shift bosses and other senior underground workers in the Klerksdorp mines. Starting with the 80 shift bosses at Stilfontein, six at a time were given a week's intensive training, other officials also attending. The subjects dealt with included stores requisitioning, labour transfer and distribution, accident reports, leadership, supervision, planning of jobs, stoping methods, and duties. The course was strengthened by a follow-up procedure which checked the work of the shift boss on returning to his normal job. The original work has now been discontinued as the need for regularization of working methods has been met and routines established. " On-the-job " training has, however, been found necessary as an adjunct to changes in mining methods and this work has been extended to cover the various crews at work in each shift boss's section. Buffelsfontein has now adopted an " on-the-job " procedure in which training staff watches the work and corrects any weaknesses observed. Fortnightly discussion groups are used to make technically minded supervisors more " management conscious ". The general effect of the classes has been to decrease turnover in shift bosses and to raise working standards. Ventilation and effective rock breaking are among the things which have shown marked improvement.[1]

* * *

In foundry casting the use of a ladle addition of tin increases the Brinell number of the iron and reduces variation of hardness between castings. The ladle additions are made in the form of 2-oz. discs of metal to the molten iron, through which it rapidly disperses without appreciable volatilization loss.[2]

* * *

An interesting project taking shape in Luxembourg has been made possible after nearly 40 years of discussion, now that Europe's political frontiers are being softened by post-war rethinking. This is a reservoir on top of the highest hill in the Duchy, which will hold a pumped storage of 4,000,000,000 gallons of water, making it the biggest of this type of arrangement in the world. From the reservoir shafts fall to the banks of the small River Our. Construction is international, with nine participating countries represented. The water of the Our is being backed up by a dam which will give a lake some miles long, from which water will be pumped at night by off-peak electricity, to be used during the day when there is a peak demand on the grid system. This water, which will recirculate repeatedly, is to be pumped up 900 ft. and the ultimate power output will be 800 MW. Within 100 miles are the Ruhr, the coal and steelworks of central Belgium and north-east France, and Luxembourg's iron mines, and this installation, which can switch from storing to output in 80 seconds, should be a valuable balancing force when it starts up next year.

* * *

The preparations of satisfactory thin sections of certain friable rocks and sediments for microscopic examination presents the geologist with many problems, not least of which is the breakdown of the specimen due

[1] *J. S. Afr. Inst. Min. Metall.*, Jan., 1961.
[2] *Tin and Its uses*, No. 51, 1961.

to its brittleness and incoherence. Recent experiments at the Royal School of Mines have shown, however, that this problem can be simply and inexpensively overcome by impregnating the specimen, prior to sectioning, with a polyester resin—Bakelite Resin DSR. 19098. The method adopted is to cut, where possible, a 3–4 mm. thick section from the specimen. If the material is so incoherent that it is considered unwise to attempt to cut a slice the whole lump should be impregnated with resin and treated after hardening as a normal hard rock, the slice being removed with a diamond saw. The sample is first thoroughly dried at 105° C. to avoid the possible formation of water vapour bubbles and then immersed in the polyester resin; expendable metal containers are quite suitable for holding the resin. If the sample is large it is not necessary to immerse it completely, since the resin will rise several centimetres by capilliary action. The sample and resin are heated to about 75° C. in an ordinary laboratory oven and held at this temperature for about 12 hours, by which time the resin will have acquired a treacly or even jelly-like consistency. The temperature is then raised to about 125° C. and held for a further 12 hours to 24 hours, when the resin should have acquired a tough rubbery texture and on cooling at room temperature should be hard enough to resist indentation with a mounting needle. After removal from the container the sample is ready for sectioning in the usual way.

* * *

A new nickel-alloy steel with exceptional toughness is reported by International Nickel. It contains 18% nickel and has a yield strength exceeding 250,000 lb. per sq. in. and a notched tensile strength of more than 400,000 lb. per sq. in. under severe conditions of test. It develops its high strength without loss of ductility or toughness when given a simple martensitic age-hardening treatment. In addition to the 18% Ni it contains 7% cobalt, 5% molybdenum, and under ½% titanium, with less than 0·05% carbon. Cold-forming and shaping amenity is good and the machining qualities are said to be excellent.

* * *

The house magazine of an aircraft firm [1] gives some information on current investigation into the noise produced by jet aircraft engines. The " nuisance value " has increased in the vicinity of aerodromes to a point where it is an obstacle to further progress in power development. Most of this noise is generated as the jet mixes with the surrounding air, but a subsidiary source is the air intake. The human ear is most affected in the mid-range of audibility, so the " perceived noise decibels " are increasingly used as the standard of reference. A site for the test work had been found which is fairly flat and unobstructed and, though remote from buildings, is reasonably accessible. This is at Larkhill on Salisbury Plain. A mobile test unit has been designed for each of two engines under examination and both intake and exhaust noises are measured radially at suitable angular and linear distances. In addition to the ground-level noises those emitted in flight are being worked on.

[1] *Bristol Siddeley Journal*, Winter, 1960–61.

* * *

Copper was known to be used in ancient Egypt from about 3,200 B.C. Triangular daggers over 6,000 years of age have been found in old graves. The copper is believed to have come from the desert regions of Sinai, Asia, and Cyprus. Sinain orebodies are thought to have varied in width between 2 ft. and 5 ft. and to have contained copper assaying between 5% and 15%. They were worked to a depth of some 135 ft. by prisoners of war and slave labour, ore being severed by fire-setting, followed by a water quench. Copper metallurgists developed considerable skill as time went on and, in addition to the use of copper both as a solder and in making jewellery it was fashioned into tools, piping and carpenters' instruments. Later the " lost wax " method of casting came into use, for producing statuary. The Pharaohs received tribute in copper as well as in gold. One record from Isy (probably the name refers to Cyprus) speaks of 108 blocks of copper. Monetary values were fixed in terms of the metal and pieces of wire, each weighing 3 oz., were used as measures of value. At one time an ox cost 111 such wires and a donkey seven.

* * *

Writing in *Horizon* for March, 1961, Ted Scannell has a number of interesting

things to say about the effects of lightning, particularly on the Copperbelt. The heavy mineralization of the area is not believed today to have any connexion with the high incidence of electrical storms, which are considered due to convergence of weather systems in that zone. Lightning may actually strike upward from the earth and is then more damaging than when it occurs in other ways. Contrary to the old proverb, it can, and often does strike more than once in the same place. The Empire State building in New York, it is said, has been hit 12 times in 20 min. and as often as 50 times in a year. Any steel-framed building is itself a lightning conductor but for many purposes copper rod is also used. One accident with explosives which killed 30 men during the sinking of a South African mine shaft was due to the striking of the headgear by lightning as a round was being prepared for blasting. Today shafts are well protected by lightning conductors and no shaft work should be done while a storm threatening to produce lightning is imminent. Transmission lines are also vulnerable and the techniques for their protection have been greatly improved in recent years. The towers are bonded to the ground and on the Copperbelt there is a counterpoise circuit running below, to which each tower is bonded. Surge diverters operate like safety valves to let off any lightning which finds its way into the distribution system. The lower the voltage of the transmission line the greater would appear to be the chances of interruption of supply when lightning strikes.

* * *

The photo-elastic method of stress analysis was discovered more than a century ago, when David Brewster found that when a transparent object is subjected to stresses the optical anisotropy which results is proportional to the deformation of the material. It has long been routine practice to study clear plastic models in order to locate the strain patterns and points of high loading. The technique has now been extended to the study of underground stresses, by coating the rock with a special transparent plastic in such a way as to bond the applied layer, which can then be examined through a reflecting polariscope. This lightweight meter can be used in the mine and direct readings are given over a wide range of working temperatures. The average accuracy with which the directions of principal stress are shown is *plus* or *minus* 3° and the method is sensitive to a strain as low as 20 micro-in. per in. Using regular checking, changes in stress pattern can be watched and the deformation checked as mining proceeds and the load on a shaft lining or stope pillar is varied, thus giving better fore-warning of danger.

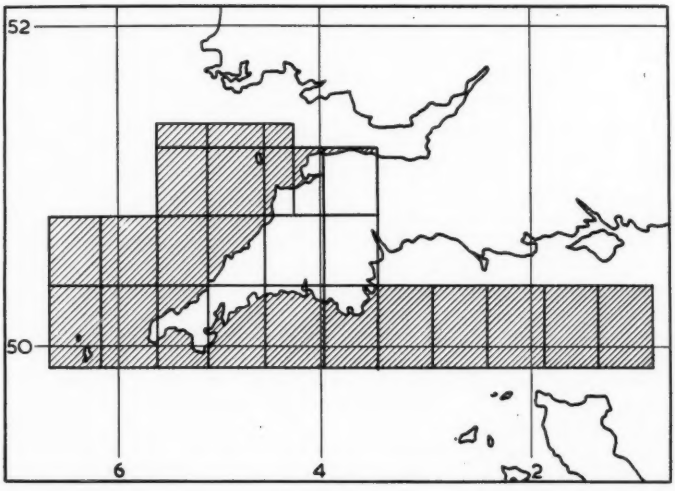
* * *

Construction has commenced at three points on the largest oil pipeline in the East—a 720-mile project designed to move viscous crude oil from Upper Assam to two refineries, one in Assam and the other in Bihar, India. Nearly 84,000 tons of steel will be used and a maximum oil flow of 4,000,000 tons annually is planned. The line is to cost £33,000,000 and will be laid in two stages—260 miles at 16 in. and 460 miles at 14 in. diameter. It will have central control capable of shutting it down completely or in isolated sections and a radio-communications network. Eight pumping stations at 90-mile spacing will be used and the line will pass through rice fields, tea gardens, forests, hills, and swamps. A mile-long suspension bridge will take it across the Brahmaputra River. The pipe has cathodic protection and is buried in a 4-ft. ditch. It will increase India's production from its present 8,500 barrels per day to 65,000.

Survey around the Cornish Coast

An airborne geophysical survey over the Western English Channel and the sea area south-west of the Bristol Channel is being carried out for the Department of Scientific and Industrial Research (Geological Survey and Museum) of the United Kingdom by an aircraft and technical team from Hunting Surveys, Ltd. The survey, which is part of a national programme by the D.S.I.R., is to be magnetically tied into the previous airborne magnetometer surveys of Cornwall and Devonshire carried out in previous seasons.

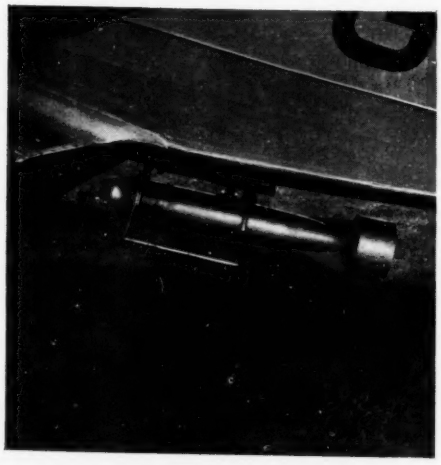
The current season's work necessitates flying about 14,000 line miles of magnetic profile, the reduction of all the magnetic data obtained on the flights, and the production of total magnetic intensity maps at a scale of 1 in. to 1 mile. The whole of the area of the survey is being covered by a grid of parallel



Area of Survey :
Shaded portion shows the 2 km. grid.

flight lines flown north–south and spaced 2 km. apart ; tie-lines spaced 10 km. apart are flown east–west, and control lines at 50 km. cover the whole area and are continued across the peninsular to provide a complete closed control network joining the sea areas to the north and south of the land mass and to link this year's survey with the work of previous seasons. The whole operation is flown at 1,000 ft. ground or sea clearance. Close planning co-operation is maintained with commanders of firing ranges along the coast through local flying control and notice of the operation has been given by a recent "Notam" published by the Ministry of Aviation.

Interior View of the DH 89a.



Magnetometer in Its Cradle.

The survey is being flown in a DH89a Rapide aircraft. The magnetometer is a recording fluxgate total-force instrument, produced by Gulf Research and Development, which is carried in an external cradle underneath the fuselage for take-off and landing and towed below the aircraft while the survey is being flown. Height is recorded by an APN.I.-type radio altimeter. Navigation and position fixing over the sea is controlled

by Decca. One set of dials is photographically recorded for subsequent analysis of the flight pattern while a second set of dials is in front of the aircraft's navigator for *ad hoc* tracking and position checking during the sortie. Coastal crossings and land traverses are recorded by a 35-mm. Vinten camera.

A check on magnetic storms is kept on a recording fluxgate storm warning monitor at the flying base. To date some severe magnetic storms have been recorded and have caused stoppage of flying or reflying of lines already flown; the most noticeable recent storm was due to a solar flare on July 18.

The aircraft flies with pilot, navigator, and magnetometer technician-operator. As anyone familiar with the Rapide will appreciate there is not much room to spare when crew and equipment are on board, but in many ways this elderly but very excellent aeroplane is well suited to this task. The unit, in charge of Captain R. K. Cannon, is flying from Exeter and St. Just.

News Letters

BRITISH COLUMBIA

July 11.

Production.—The release of a preprint of a section of the Annual Report of the Minister of Mines and Petroleum Resources for British Columbia for 1960 reveals that the value of gold, silver, copper, lead, and zinc production for the year was $112,735,769. Miscellaneous metals, including iron ore, nickel, tin, and minor metals recovered at the Trail Smelter, had a value of $17,714,969. The total quantity of ore mined at all lode mines amounted to 8,242,703 tons and came from 67 mines, of which 31 produced 100 tons or more. The average number of employees in the lode-mining industry including mines, concentrators, and smelters was 7,423.

The Trail smelter recorded custom receipts of 10,043 tons of ore from 30 properties, 9,468 tons of which, from seven properties, obtained a silica bonus in excess of the treatment charge. The smelter also recorded custom receipts of 1,228 tons of lead concentrates and 35,331 tons of zinc concentrates. Totals of approximately 15,470 tons of lead concentrates and 41,660 tons of zinc concentrates were shipped out of the Province for smelting. Copper concentrates were shipped to the Tacoma smelter, except for the output of Cowichan Copper, the copper concentrate recovered by Texada Mines, Ltd., and the copper contained in bulk nickel concentrate from Giant Nickel Mines, Ltd., all of which went to Japan. All iron-ore concentrate, amounting to 1,156,297 tons, was shipped to Japan.

Placer Development, Ltd.—The estimated consolidated net profit of Placer Development, Ltd., for the three months ended April 30, 1961, was $542,524. Mr. J. D. Simpson, the company's president, reports preparation of the mine and construction of the mill of Craigmont Mines at Merritt to be progressing favourably. Production should start in the early autumn.

Skeena.—The 25th report of Silbak Premier Mines covers the 11-month period ended March 31 last. The company received income of $28,869 from direct ore sales, $58,708 from royalties resulting from shipments by lessees, and $6,176 from interest and sundry sources. The net income was $30,433. Mr. A. E. Bryant, the company's president, informed the annual meeting that the first shipment of ore in 1961 contained 51·5 tons, of which 45 tons graded approximately $300 per ton in value, while the remainder assayed 12·0 oz. gold and 450·0 oz. silver per ton, equivalent to $800 per ton. The second shipment consisted of 51 tons with an approximate value of $270 per ton.

The control of Western Surf Inlet Mines has passed to Paul H. McCloskey and associates, of Toronto, and the company has been reactivated through an important share underwriting by Kamm, Garland, and Co., Ltd. Under the new management it is proposed to pursue a bold policy in exploration either alone or in partnership with others. It is intended to re-examine the Surf Inlet gold mine on Princess Royal Island and the McVicar mine at Squamish to obtain a new appraisal.

Nicola.—Early in July Craigmont Mines announced arrangements for the sale of copper concentrate for the first six years of production. A portion will be made available to the Tacoma smelter of American Smelting and Refining Co., with the balance, the major portion, sold under contract to three Japanese smelting companies.

An immediate programme of development is to be undertaken by North Merritt Mines on the K. W. group of 54 claims and fractions six miles due north of the Craigmont mine. The work will include detailed geological mapping and surveying, stripping, trenching, and assaying. The deposit contains a strong limonite and copper carbonate zone over a width of 300 ft.

Vanex Minerals, Ltd., has commenced diamond drilling on its 75-claim property between Ashcroft and Spence's Bridge, three drill sites having been selected. Surface indication

suggests strong mineralization along a break 200 ft. wide by 1,500 ft. long, within which is a rusty-coloured limonitic zone containing evidence of crushing, brecciation, shearing, and fault movement.

The legal survey of the Ron eight-claim group, immediately north of the Craigmont mine, is well advanced. The group was recently purchased by Friday Mines, Ltd. East-west lines are to be run at closer intervals in order to gain a new geophysical appraisal of the property.

At the end of June Peel Resources, Ltd., was in the midst of an extensive programme involving line-cutting, soil-sampling, and magnetometer surveying on its 42-claim property adjoining the Craigmont Mines property on the north.

Greenwood.—Continental Consolidated Mines, Ltd., has leased its Stemwinder copper-gold mine at Phoenix to operators who will mine and ship ore on a royalty basis. The company's Rawhide claims in the same area is already under lease to the Phoenix Copper Co., Ltd., under a similar arrangement. At other Continental holdings, a comprehensive magnetometer survey is being run on the Wildcat and Mag groups, south of Noranda's Kennedy Lake iron mine, and diamond drilling is scheduled to follow. Geochemical and geophysical surveys are in progress on the Gulf copper prospect, north of the Craigmont mine. The Ephus Syndicate, in which Continental holds an important interest, is extending a drift to the east under the ancient channel of Granite Creek, a tributary of the Tulameen River. The first raises to bedrock were productive of gold extraction, but became fouled with boulders that could not be dislodged. The new approach is being made in a section indicated to offer less impediment to mining.

Swiss Oils of Canada (1959), Ltd., which is currently receiving substantial revenue from oil and gas production in Alberta, has acquired the Crow, Raven, and Bruce groups, representing copper-gold prospects near Greenwood. The company also holds an option to purchase two separate copper prospects near the Craigmont mine in the Nicola Mining Division. An immediate programme of work will be conducted on the Crow and Raven groups under the direction of Mr. V. B. Bjorkman, the consulting engineer.

Amcana Gold Mines, Ltd., a newly-incorporated British Columbia company, plans an immediate programme of exploration and development at an estimated cost of $50,000 on a group of 20 claims and fractions 30 miles north of Rock Creek and 10 miles east of Beaverdell.

Golden.—Sheep Creek Mines, Ltd., received $1,659,551 from the shipment of lead and zinc concentrates and barite during the fiscal year ended May 31, 1961. The figure appears in a preliminary report by Mr. H. E. Doelle, the managing director, and compares with a gross value of $1,553,916 in the previous year. In the period just concluded Sheep Creek milled 201,478 tons of ore assaying 2·63% lead and 5·28% zinc and mined 4,735 tons of barite ore. Production was 4,663 tons of lead and 254,234 oz. silver, valued at $822,887, 9,462 tons of zinc, valued at $761,733, and the barite ore which brought revenue of $35,512. The net return from production was equivalent to $8·05 per ton of ore milled. Very encouraging results have been obtained from recent deep development of the company's mine at Invermere.

Yukon.—Kootenay Base Metals, Ltd., a B.C. company, has concluded an agreement to explore and develop a high-grade silver prospect near Teslin Lake, Yukon. Veins are exposed on a steep ridge over a vertical interval of 450 ft. Average grade as determined from preliminary sampling over a length of 1,000 ft. and average width of 2·5 ft. is 0·13 oz. of gold and 30·0 oz. of silver per ton, with 3·3% lead and 3·0% zinc.

Alaska.—The Columbia Iron Mining Co., a subsidiary of U.S. Steel, has exercised its option to lease and operate the Klukwan iron-ore property, 23 miles north-west of Haines. The Klukwan property consists of 91 lode claims and 92 placer claims *plus* 103·67 acres purchased outright and 869·94 acres held on leases from Indians. Eight claims are in dispute with the University of Alaska. Columbia Iron may purchase the property outright at any time for $10,000,000, against which all royalties and rentals paid prior to the purchase will be credited. The agreement is with the Klukwan Iron Ore Corporation, 65% of which is owned by Quebec Metallurgical Industries, Ltd., which is in turn controlled by Ventures, Ltd., a Canadian company. Recoverable iron from the placer claims alone has been estimated at more than 100,000,000 tons of 60% magnetite concentrate.

EASTERN CANADA

July 25.

Porcupine.—The operations of Dome Mines in 1960 resulted in a profit of $1,947,082, which compares with $1,884,326 in the previous year. Bullion sales in 1960 realized $6,025,370, the mill treating 714,600 tons of ore, an average of 1,985 tons a day. The company's ore reserves

at the end of the year were estimated as 2,476,000 tons averaging 0·259 oz. of gold per ton, against 2,494,000 tons averaging 0·26 oz. a year previously.

North-Western Ontario.—At the annual meeting of Leitch Gold Mines shareholders were informed that the proved ore reserves down to the 30th or bottom level are estimated to be requisite for five years' milling at the existing rate, the average grade having increased to 1·25 oz. gold per ton. The bottom level is not as high-grade as the 28th, 300 ft. above, which shows a continuous ore length of 610 ft. averaging 3·5 oz. cut grade across 19·1 in., the best level in the mine. During 1960 the mill treated 32,520 tons of ore, recovering $1,304,225. The profit amounted to $274,413. Ore reserves at December 31 last were estimated at 104,267 tons grading 1·094 oz., a gain from 93,425 tons of 0·786 grade a year earlier.

Sudbury.—The International Nickel Co. of Canada plans a $50,000,000 expansion programme which will triple iron pellet production at its plant in Copper Cliff. The enlarged plant is to have a capacity of 750,000 long tons of pellets annually and it is planned to have it in full-scale production by 1963. The present output is about 220,000 tons of iron pellets yearly. The project will increase the company's investment in iron ore to $75,000,000 and the value of a year's output has been estimated at $13,000,000 to $14,000,000.

Manitoba.—Sherritt Gordon Mines reports an operating profit of $1,417,000 for the first quarter of 1961 and a net surplus of $691,000, which compares with $962,000 in the corresponding period of 1960. In the period the mill at Lynn Lake treated an average of 3,147 tons per day, as compared to 3,180 tons a day in 1960. No new orebodies were discovered during the first part of the year but underground work at the Farlay shaft has, it is reported, made good headway. A vertical rise is being put up from the 2,000-ft. level to get at the bottom of " A " shaft. Once completed the rise will be cut to the full size of the shaft. The plant at Fort Saskatchewan operated well below capacity during the period, nickel production being entirely from Lynn Lake and purchased concentrate, which totalled 5,642,000 lb. This compared with a total of 8,389,000 lb. during the same period last year.

Quebec.—In the first three months of 1961 Copper Rand Chibougamau Mines treated an average of 1,642 tons per day, production amounting to approximately 7,300,000 lb. of copper, 8,500 oz. of gold, and 26,000 oz. of silver. Copper and gold recoveries were 95% and 83% respectively. The company has started deepening the main production shaft from 1,450 ft. to 2,130 ft. and this will be completed during this year. The work will provide four new levels. Further drilling is to be carried out after the required driving is completed on the 1,300-ft. level, where encouraging results have been obtained.

In the first two months of the current year gold shipments from Quebec Province totalled 180,091 oz. and those of silver 724,058 oz. Asbestos output for the same period amounted to 110,322 tons.

The new lithium refinery set up by the Quebec Lithium Corporation is producing some 7,000 lb. of lithium carbonate daily, using a process discovered by the Quebec Department of Mines. Expansion is contemplated and the directors have authorized an addition, which will provide for production of lithium hydroxide monohydrate from lithium carbonate.

Shareholders of Camp Bird have been informed that drilling by Prospectors Airways in the Joutel township areas has resulted in favourable ore intersections showing copper values averaging 2·44% over an average width of 23·7 ft. along 700 ft. of strike. A new company is to be formed to develop the area.

AUSTRALIA

July 20.

Costs and Industry.—The continuous rise of costs in the mining industry is a matter for growing concern. It was stated recently by the President of the Chamber of Mines of Western Australia that the continuing upward movement in costs was worsening the economic situation at an accelerating rate. He instanced four quarterly increases in adjustments of the Goldfields basic wage in 1960 which had increased wages by 13s. 2d. per week, making a minimum weekly wage of £A16 12s. in the industry, in addition to which there are marginal increases and district allowances. The gold-mining industry is already in a difficult position, but an additional burden has now been placed upon it by the basic wage determination of the Commonwealth Arbitration Commission which has awarded an increase in the basic wage of 12s. per week. This court did not vary the hours of work, but the Western Australian Coal Industry Tribunal earlier in the year increased the annual leave in the coal industry in that State to four weeks per year. The Tribunal, however, refused the Union application to have the increase made retrospective to last year.

The matter of annual leave applies in this case to one industry in a particular State, but this grant will be applied in future applications in other States and can well be made a decisive point in awards under consideration. The recent award of an increase of 12s. per week will make the basic wage in Perth £A14 8s. per week and will be reflected on the mining fields in due course. It is contended that the increase could be absorbed in existing over-award payments, but this is impracticable. Other industries can pass the addition on, but this is impossible in the mining industry, which is loaded, in addition, by the price rises in all industries contributing to the needs of mining.

New Power Plant.—In an effort to meet rising costs, North Kalgurli (1912), Ltd., is to build its own power plant at a cost of £A300,000. Hitherto, North Kalgurli has purchased power from the Kalgoorlie Electric Power and Lighting Corporation, but the company anticipated that by building its own power plant, a saving of between £A30,000 and £A40,000 per year can be made. Present power charges are 8s. 6d. per ton of ore treated and it is expected to reduce this to 5s. 6d. per ton. An order for diesel engines and alternators has been placed with Hawker-Siddeley Brush International, Ltd. Each unit will be of 1,650 h.p. and four power units have been ordered. The North Kalgurli mine treats an average of 28,500 tons of ore per month for a recovery of some 7,000 oz. of gold.

Beryl.—A discovery of beryl that may prove of commercial importance has been made in Western Australia. The new discovery has been made 50 miles north of Yalgoo, an old gold-mining field 300 miles north of Perth. So far, the mineral has been recovered from shed surface material and costeaning, but crystals have been reported as up to 3 ft. across, which suggests that the containing pegmatite dyke may be of some size.

Sale of State-Owned Mine.—State ownership has consistently been prominent in the objectives of Australian labour. The Collinsville State-owned coal mine in north Queensland has been sold to private enterprise, however, together with the associated coke works. The reason behind the sale is the succession of stoppages and the resulting financial losses which had accumulated to a substantial figure.

Tableland Tin.—Tableland Tin Dredging N.L., at Mount Garnet, North Queensland, is to commence new practice in removal of overburden ahead of the tin dredge. The initial contract is for the removal of 1,000,000 cu. yd., of overburden with a depth of 20 ft. This work will be followed by a dredge, and, if the work is as successful as anticipated, further contracts will be let. The company is now on good ground and with Ravenshoe Tin Dredging is likely to carry the tin production of Queensland for a considerable time.

Power Projects.—The expansion of the Bell Bay aluminium smelter to a capacity of 44,000 tons of metal per year is raising some discussion in Tasmania on the question of power. The decision in favour ot hydroelectric power from a new plant to be built on the Derwent River is being questioned and a case advocated for thermal power generated from coal in the Fingal Valley deposits. It is, of course, a matter of costs, in which politics will have a large interest. The collieries in the Fingal Valley represent a substantial capital investment, and an avenue for employment. They are in a depressed condition in the face of electric power generated at the Island's hydro-electric operations centred on the Great Lakes, and the potential demand for power at Bell Bay with the possible relief of the situation there, is likely to attract considerable political attention.

This may also become an issue in the projected aluminium industry in Western Australia, where the question has been raised on the utilization of the State's power potential, rather than establishing the new industry in Victoria. The problem there is both a matter of cost of thermal power generated at the two locations, and the supply of adequate fuel. In Western Australia, the production of alumina at Kwinana, would depend on coal from the Collie field, where the supply of coal that can be mined by open-cut operations is not large. The deposit at Anglesea, Victoria, is estimated to contain 400,000,000 tons of open-cut coal, of which 250,000,000 tons are considered to be of high grade. This fact, and its readily availability, with low production costs, are considered to outweigh the cost of the 1,700-mile voyage for alumina from Kwinana to Geelong.

Coal.—The coal trade with Japan continues to attract attention to the mining and export of New South Wales and Queensland black coal. The latest entrant to the prospecting field is the Utah company, the area of interest being the Kianga-Theodore field, near the east coast of Central Queensland, and near the Kianga-Moura locality, which is now being actively worked by open cut. The area is 250 miles north-west of Brisbane and prospecting licences extend over 80 sq. miles. It is expected that Utah Australia Ltd., the mining subsidiary of Utah Construction, will commence test drilling at an early date.

Uranium.—The importance of an active development policy is illustrated by the case of one of the smaller uranium ore producers in the Northern Territory. This company, United Uranium N.L., has operated successfully, but has announced that the known ore reserves will be heavily depleted in producing its 1962 quota for the U.K. Atomic Energy Authority. It is believed, however, that prospects for proving sufficient additional ore are good and that before the depletion of reserves, sufficient additional ore should be proved to complete the contract. Three new shoots have been located on surface.

The opening up of the new ore-body at Rum Jungle, has assured ample ore for continuance of mining and treatment operations there so that the problem will be one of sales.

FAR EAST

July 24.

Malaya.—Mr. J. R. Lee, the retiring Chief Inspector of Mines, said in a farewell interview in Kuala Lumpur that although tin would continue to be produced in Malaya for many years to come, it must be expected that output would decline gradually as many of the richer deposits had been exhausted. Even if the present level were to be maintained every effort would be needed and all available land required although the future of the industry would depend largely on the ability to work ground of ever-decreasing grade. There had been a very large amount of prospecting after the war and despite the Emergency, but the results had been disappointing, no new tin fields having been discovered. It is clear, he thought, that if the present level of production was to be maintained the search for new deposits or extensions of known deposits had to be intensified. He thought the Malayan tin industry had passed its peak and that it was unlikely that it would ever reach its post-war production record of 62,300 tons in 1956.

The annual report of the Commissioner of Lands and Mines for Pahang State, Malaya, for 1960, recently published, says that a great deal of work has been done on prospecting and mining applications. The report, signed by J. B. Melford, explains that the post of Senior Lands Officer, Pahang, was re-designated Commissioner of Lands and Mines in 1959 and that during 1960 this post was filled by Tuan Haji Anjang Saith bin Haji Abas, succeeded in January, 1961, by Mr. Melford. During 1960 a total of 312 applications were disposed of, which reduced the backlog to manageable proportions, although applications poured in at such a rate that at the end of December the number outstanding was still 279. The vast majority of such applications were by people who were neither qualified nor had sufficient capital to prospect, but recommendations to increase the deposit to secure prospecting and make it payable on application to prevent speculation were not accepted by the Executive Council. There had, however, been encouraging signs of finds of iron ore, some of which would lead to the issue of mining leases in 1961. No tin worth mentioning had been found.

Mr. A. W. Burne, Deputy Chief Inspector of Mines recently suggested that a lot of mineral wealth was being lost because of inefficient mining and mineral dressing techniques. However, the Mines Department was stepping up research by engaging two more officers and expanding its laboratories at Ipoh. A mineral dressing engineer, Mr. R. A. Couche, had been loaned to Malaya by the Australian Government under the Colombo Plan and another was expected from Australia later this year.

Prospecting for iron ore was carried out during 1960 over parts of one of the Kulim Rubber Plantations, Ltd., Kedah estates by a Chinese mining firm. The work was continuing, the annual report states, and so far the firm has exercised its option to lease areas for mining on terms which provided for the payment to the company of a total minimum royalty of about £53,000, subject to Government mining certificates being obtained.

When Japanese experts choose a site, preliminary work is to start on an iron and steel mill to be set up in the Federation. The plant is to be built on the west coast as a joint Malayan–Japanese venture and Senator T. H. Tan, who signed an agreement with a representative of Yawata Iron and Steel Company in Tokyo recently, said in Kuala Lumpur that several possible sites had been chosen, one at Lumut, on the Perak coast. The arrangement was for 51% of the capital for the plant to be raised in Malaya, while Yawata Iron and Steel would furnish the rest.

India.—The Indian Government has announced that exporters of manganese ore are to be allowed to get equipment and machinery from abroad for improving their mines to the extent of 5% of the foreign exchange earned by them. An additional 5% might be allowed in special cases.

SOUTHERN AFRICA

Institution Centenary.—The Institution of Certificated Mechanical and Electrical Engineers (South Africa) has celebrated its golden jubilee, on which it was congratulated by the president of the Transvaal and Orange Free State Chamber of Mines, Mr. H. C. Koch. In the course of the proceedings on July 20, presided over by Mr. O. Rau—president of the Institution, Mr. Koch presented to Mr. R. Blair a commemorative plaque he had been awarded for technical developments in the industry. A practical man, Mr. Koch said of Mr. Blair, who has pioneered equipment developments which have made high-speed shaft sinking practical and have made it possible to hoist from ultra-deep shafts.

In reviewing " the development of the gold mining industry, its contribution to the economy of South Africa over the past 50 years and its role in the future," Mr. Koch commented that full Government co-operation, and political and economic stability in the country, are important factors in the industry's ability to carry on this work which will require the financing and opening up of new mining areas and the extension of mining operations to greater depths in existing areas. Notwithstanding the current phase of uncertainty in these respects there is no holding back by the industry on this account.

In a tribute to the engineering profession Mr. Koch commented that its tasks of developing methods and processes and designing, operating, and maintaining the machinery of mining operations have been carried out faithfully and with great distinction. Today manufacturing capacity in South Africa enabled the mining industry as a whole to buy 90% of its requirements in the country and there is a large consumption of locally-made oxygen, cyanide, and other chemical products. Much of the industrial expansion is concentrated in the Southern Transvaal, where more than 4,500 industrial plants have been established along the Witwatersrand line.

While secondary industry is now established in its own right, Mr. Koch said, gold mining remains the largest single industry, the largest prime generator of income, and accounts for almost half the country's export revenue. In 1960 total exports were valued at R1,362,000,000 and gold-mining products accounted for R672,000,000, while diamond and other mines added a further R154,000,000. Manufactured exports were valued at R192,000,000 and agricultural exports at R344,000,000.

Regarding the future Mr. Koch said record production of gold leaves no room for complacency. The industry itself was not satisfied about the gold price, but could not make any assumptions on that account in the planning of operations. The industry is also not complacent about research, on which more than R2,000,000 a year are being spent and in which further improvement is indicated, particularly in respect of stoping efficiencies and the transport of ore. Deep-level mining operations depend to a great extent on the degree of success attained in the control of working costs, improved use of available resources and increased productivity, and the resolution of new mining problems as they arise.

Winder Arresters.—In a recent address to the South African Institution of Mechanical Engineers A. W. P. Hallett indicated the considerable thought being given to the problem of arresting an overtravelled conveyance hoisted by friction winders. The difficulties associated with the system of wedge guides and jack-catches lie in calculating precise effects and the impossibility of guaranteeing consistency of effects from day to day. The operators of friction winders have been striving and are striving to evolve a last line of defence, certain in its reliability and safety and minimizing the risk of damage to equipment and injury to personnel. Particularly in the case of automatic winders there is felt a need for provision against freak circumstances additional to the normal safety devices.

Mr. Hallett reviews three types of arresters, other than wedge guides —namely, nylon rope, compressed air, and the hydraulic buffer, all of which could absorb rather than store kinetic energy. With nylon rope the retarding force depends on the stretch and nothing else ; it cannot provide a retarding force proportional to the square of the entry velocity. It is also expendable and its behaviour erratic. At the same time the choice of hydraulic buffers seemed largely a matter of technical taste.

In considering the hydraulic arrester Mr. Hallett showed that the stroke length is independent of the initial velocity and depends only on the weight of the body, meaning that an arrester having a given orifice will bring a given mass to rest in the same distance whatever the velocity of entry. It deals effectively with conditions in which large amounts of kinetic energy have to be absorbed in a very short time and distance without impact or shock and without damage or injury. On the question of the out-of-balance load at best a compromise must be effected, a reasonable assumption being to calculate the orifice area on a total weight for retardation

which is increased by 10%. This would give under-protection for low velocities of entry, but over-protection for higher velocities. The fluid chosen for mining applications was a light oil, s.g. 0·885, with a viscosity about the same as water at normal temperatures—a fluid non-corrosive during long periods of idleness.

At No. 5 shaft, West Driefontein, the hydraulic arrester installation consists of two 8-in. cylinders on each side of the winding compartments, each with its own reservoir. Each opposing piston is connected by a steel-wire rope, 1·75 in. in diamter, the two ropes straddling the compartments. The equipment was installed without quantitative tests, as the shaft was about to be commissioned and immediate protection was considered necessary. Within a few weeks of the installation the single drive from the drum shaft to all the safety devices failed. An overwind resulted, in which a full 15-ton skip entered the tip at 25 ft. per sec. The arrester brought the system to rest within 18 in. of the limit of travel. The only damage was distortion of the bottom-discharge skip, the opened door of which fouled a reinforced-concrete beam. Mr. Hallett concluded that similar installations could be applied to conventional drum winders in either vertical or inclined shafts.

New Railway.—Agreement has been reached between the Government and the Phosphate Development Corporation (Pty.) Ltd., for the construction of a railway from Hoedspruit to Phalaborwa in the north-eastern Transvaal, 31½ miles in length, at a cost not exceeding R4,134,000 approximately. The line will be constructed for the main purpose of base-mineral traffic—defined as phosphate concentrates, fertilizer, and any base minerals (crude, partly, or wholly processed in the Magisterial district of Letaba), and any other authorized product in terms of the agreement.

News from the Mines.—Western Reefs Exploration and Development has virtually completed operations preparatory to full-scale sinking of its No. 4 shaft in the northern section, including equipping of the headframe and installation of the winders. From the depth of 312 ft. sunk in the preliminary work the 26 ft. lined diameter shaft, bratticed for up/down-cast ventilation, will be sunk to a final depth of 6,700 ft. and equipped to handle men, materials, and waste-rock to a tonnage of about 45,000 tons a month. The shaft is being sunk specifically to serve operations on the Vaal Reef horizon in the northern section and the ore will be transferred through a high-speed haulage system, 12,500 ft. long, to the existing No. 3 shaft to the south. The siting of the No. 4 shaft suggests that in due course workings in the section may be connected up with workings in the southern Zandpan mine, in which section two shafts have been sited.

Western Deep Levels has commissioned the Koepe winder at the No. 2 vertical main shaft, sunk to a final depth of 6,309 ft. At the No. 3 ventilation shaft, being sunk in one stage to a final depth of 10,000 ft. approximately, the fan drift has been completed and the fans installed.

Vaal Reefs has commissioned the Koepe winder at the main shaft of the No. 2 shaft system in the south-central section and finished the surface rail-line from the shaft to the gold plant. This plant, which milled a monthly average of 106,000 tons in the second quarter, has been expanded to a capacity range of 125,000–150,000 tons a month. The pipe-line to the Western Reefs uranium plant has also been completed and commissioned and the company's uranium plant placed on a care and maintenance basis.

Operations in the high-grade northern section of Western Holdings, which have been restricted by inadequate ventilation, should now be expanded in the immediate future with the completion of the new ventilation shaft, ancillary to No. 1 shaft. The 20 ft. lined diameter ventilation shaft was recently completed to a final depth of 4,563 ft. in the immediate vicinity of the No. 1 rectangular unit, up to the present bratticed for down/up-cast ventilation. Sinking the new ventilation unit was accomplished in less than nine months.

South African Land and Exploration, which recently completed sinking the vertical component of its Withok shaft, No. 3 shaft, to a final depth of 4,051 ft. in the northern section of the Withok sector, has completed excavation of the hoist chamber for the sub-vertical component and sinking proper is now imminent. This component will be sunk to a final depth of about 7,450 ft. within 12 months or so. The vertical component facilitates an extension of development in the northern Withok section; the sub-vertical component will facilitate development in the downcast, more southerly Withok section, where it has been indicated a north-west to south-east payshoot zone may be disclosed.

Harmony Gold Mining is now stripping the ventilation shaft of its remaining equipment, used during the period of hoisting in the shaft, and the increased ventilation flow, already improved, will increase further when the operation has been completed. Three fans have been commissioned and a fourth is now available

Drilling overburden at Associated Manganese Mines.

as standby—each of 450,000 c.f.m. capacity. In the gold plant the last two 16 ft. long by 12 ft. diameter mills have been installed and commissioned and the plant capacity has thereby been raised to the 200,000–240,000 tons monthly range. In one of the two haulage systems advanced westwards from No. 2 shaft the de Bron Fault was encountered about 6,000 ft. west of the shaft. The fault strike is roughly parallel to the western boundary and about 3,000 ft. from it at the point of intersection, where the downthrow on the western side is about 2,500 ft. and the fault dip about 65° to 75° westwards. This indicates loss of ore-ground, with suggestions that the throw decreases to the south and increases to the north. However, the company does not plan to develop and mine west of the fault for many years. The immediate plan for development provides for extension of operations between the two shafts.

Both components of the No. 1 Twin-shaft system of Bracken Mines Ltd. have now been equipped and are now in commission. Development on reef has now been in progress for two quarters, payability being about 83% and average payable values 434 in.-dwt. for 2,285 ft. sampled. The indicated bore-hole grade range was about 420 in.-dwt. to 500 in.-dwt. and payability about 50% to 60%.

In its first quarter of development on reef Leslie Gold Mines reported payability of 77% and payable values of 313 in.-dwt. The indicated bore-hole grade range was about 300 in.-dwt. to 420 in.-dwt. and payability about 40% to 60%. One of the two components of the No. 1 Twin-shaft system has been equipped and commissioned; the second, which is the main component, has been virtually completed to its final depth of about 3,100 ft. and equipping will follow.

Buffelsfontein has completed equipping its No. 1 sub-vertical shaft in the north-western section and should complete preliminary work on the eastern twin-shaft system in the immediate future. This system consists of a 28-ft. lined diameter main and a 22-ft. lined diameter ventilation shaft. The gold plant capacity has been expanded to the 200,000 tons to 240,000 tons a month range and the actual milling rate should gradually rise to about the 180,000 tons a month mark.

Stilfontein Gold Mining is now sinking its Scott Shaft, a 26-ft. lined diameter unit which will be completed to a final depth of about 6,500 by about 1964. It is situated about 4,000 ft. south-west of the Margaret Shaft.

First preliminary bore-hole results from exploration by Freddies Consolidated in its western section, along a line representing the southern extension of the narrow zone of enrichment on the Elsburg horizon, have been satisfactory in respect of values. Indications are that the persistence of the Elsburg multi-reefs into the Freddies Consolidated mine is limited to a small zone in the western section, perhaps of the order of 60 or less claims with relatively high values and a high claim tonnage. It would therefore appear not unreasonable to expect

some arrangement to be negotiated between the Loraine and Freddies Consolidated companies for the former to exploit the claim area of Elsburg ore in the latter's western section, unless, of course, the latter feels that it is justified in incurring the capital expenditure involved in developing the Elsburg zone, which with the Kimberley Reefs mentioned, is bedded from about 400 ft. to 1,025 ft. above its present workings.

Hartebeestfontein Gold Mining is in the final stages of sinking and lining its No. 4 shaft in the south-western section. In a bore-hole to the north in the extreme western section, near the common boundary with the Zandpan mine, three intersections of the Vaal Reef at depths of 7,678–9 ft. disclosed values of 267, 168 and 141 in.-dwt., one intersection of the horizon disclosing faulting out of the reef.

Zandpan Gold Mining is in the final stages of sinking its No. 1 shaft in the south-central section to a final depth of 7,500 ft., which should be reached in the current quarter of shortly thereafter. Bratticed for up/down-cast ventilation the shaft should be equipped and commissioned early next year.

Drilling continues in three of the four bore-holes sunk by West Witwatersrand Areas in the vicinity of the south-eastern section of the Libanon mine. It is understood that drilling may be extended further.

Free State Saaiplaas has deferred equipping the mine to expand treatment capacity from 75,000 tons to 100,000 tons a month, due to retarded development resulting from water-bearing fissures, faulting, and an apparently unpayable zone in the neighbourhood of No. 2 shaft. The development rate will be advanced as rapidly as underground conditions permit.

Libanon Gold Mining which is upcasting part of its ventilation flow through the shaft systems of Venterspost is now to provide alternative upcast facilities by sinking a 22-ft. lined diameter shaft to 2,400 ft. in its sub-outcrop zone at an estimated cost of R876,000.

New Drill Steel.—Avesta South Africa (Pty.), Ltd., the products of which are marketed in South Africa by Holman Bros. (Pty.), Ltd., recently introduced a new high-quality drill-steel (Group 20) which has markedly improved fatigue qualities makes possible drilling of longer and larger holes and the use of longer rods. In order to extend this characteristic to a greater rod length the Avesta has installed and commissioned a new Wild-Barfield vertical pit type, electrically heated, gas carburizing furnace at their Witwatersrand works. This furnace operates at a maximum temperature of 1,050° C. with a rating of 234 kW. in three equal zones. The retort has a batch capacity of more than 6 tons and accommodates rod lengths of 12 ft. Special features are the hydraulically-operated furnace door and fully-automatic control, panel mounted.

Trade Notes

Brief descriptions of developments of interest to the mining engineer

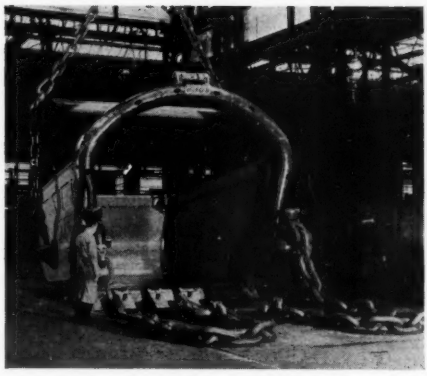
Underground Coal Carrier

A tipper chassis shipped out to South Africa by **Albion Motors, Ltd.,** of Glasgow, has been specially adapted there for use as an underground coal carrier and is now operating at a Witbank colliery. Based on a 94-h.p. diesel-engined Albion Chieftain chassis, the vehicle was re-assembled underground after being transported down the shaft in two sections. Modifications to the chassis include the replacement of its constant-mesh gearbox by a Brockhouse torque convertor because of the vehicle's continuous " stop-start-reverse " cycle of operations over a run of about 200 yd. It also has a special dashboard on which warning lights have been included amongst the normal instruments, for easy recognition in bad lighting at the coal face. A special exhaust filter of the water-scrubbing type and an air cleaner are fitted to the engine. The latter is a Donaclone 2-stage type and is claimed to be so efficient that under adverse conditions $\frac{3}{4}$ lb. of dust has been collected from the detachable dust receiver after little more than one hour's engine operation.

The Chieftain is equipped with a special tipper body by **More-Wear Body Construction (Pty.), Ltd.,** of Elandsfontein, which accommodates wheel arches designed so that no coal stays behind the arches after tipping. The body is tipped by twin Meiller rams which are set very low in the chassis. This has allowed the body to be mounted low, so that it can tip in less than 9 ft. 3 in. headroom. The carrier is shown in the accompanying illustration.

Large Dragline Bucket

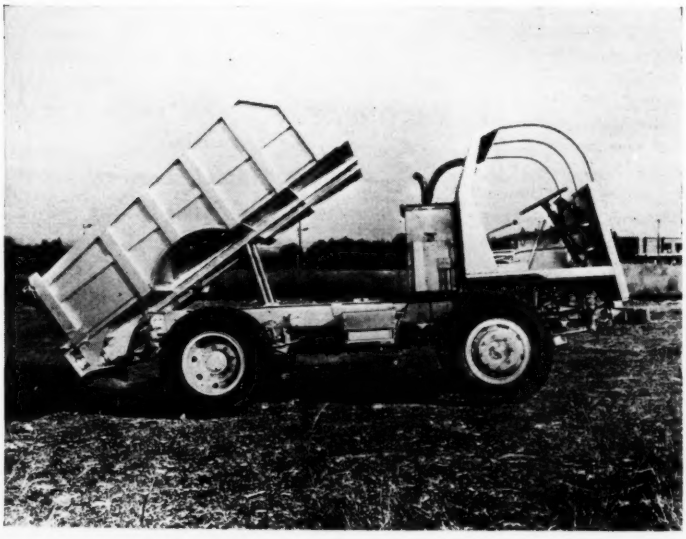
Shown here is an illustration of a 40-cu. yd. dragline bucket recently completed by **Hadfields, Ltd.,** of Sheffield, delivery of which has been taken by the National Coal Board. This " Esco " bucket, the largest of its kind, weighs 33 tons 13 cwt. fully rigged and when loaded approximately 90 tons. The overall dimensions are : Length 19 ft. 6 in., width 13 ft. 9 in., and the height 14 ft. 6 in. It is operating on a Ransomes and Rapier W.1800 walking dragline.



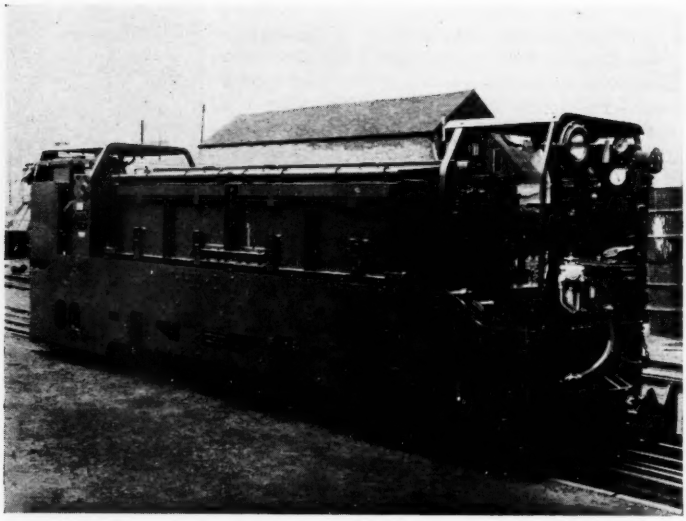
40-cu. yd. Dragline Bucket.

Battery Locomotives

The Traction Division of **Associated Electrical Industries, Ltd.,** has made improvements and modifications to the design of the 14-ton type DBF12 approved storage battery locomotive. The attached illustration shows one of these locomotives ready for despatch to Manton Colliery, in the N.E. Division of the National Coal Board. The most important modification is the introduction of a new type of battery-isolating switchbox and battery container. The switchbox is mounted at one end of the container and access to the battery plug is from the side of the locomotive. Each container is identical and interchangeable and is designed to accommodate 48 lead-acid cells. When commissioning batteries there is no need to handle live connexions below ground. The battery containers are designed so that they may be joined together by a substantial bolt joint so as to form a single unit for the purposes of battery changing by the roll off method. In addition, with battery-isolating switchboxes at opposite ends of the



Albion Chieftain Tipper Truck.



A.E.I. Storage Battery Loco.

battery, it is not now necessary to ensure the locomotives always enter the battery changing station with the same cab end leading.

A further improvement in the design of the locomotives has been the introduction of a central joint in the main frame whereby the locomotive can be quickly split into two sections for transport into the mine.

Personal

R. C. ATHERTON and W. W. CONNOR have been appointed directors of New Broken Hill Consolidated.

A. M. BAER has been appointed chairman and Lord BAILLIEU deputy chairman of the Consolidated Zinc Corporation, in succession to the late L. B. ROBINSON.

C. M. G. BOLTON is returning from Irak.

P. H. A. BROWNRIGG has been appointed a director of the Rhodesian companies in the Anglo American Corporation group.

M. I. FREEMAN has been appointed deputy chairman of the Imperial Smelting Corporation, Ltd.

C. B. GEE is home from Northern Rhodesia.

C. R. JOHNSON is home from Sierra Leone.

T. H. KINDERSLEY has been appointed chief engineer of the Engineering Products Division of Allis-Chalmers, Great Britain, Ltd.

D. M. MCKINNON has been appointed Consulting Geologist (Rhodesia) to the Anglo American Corporation of South Africa, Ltd., in place of Dr. H. C. GUNNING who has completed his tour of service with the Corporation.

J. W. MASSIE has left for South Africa.

M. MENDEZ-AROCHA has left for Venezuela.

R. H. A. NEUSCHILD has been elected chairman, of Lake View and Star, Ltd.

B. WHITE, recently graduated from Birmingham, is now working at Hamstead Colliery.

A. R. O. WILLIAMS has been appointed a director of Konongo Gold Mines, Ltd., in place of J. D. MCCALL, who has resigned.

THE INSTITUTION OF MINING AND METALLURGY

Elections and Transfers

Member.—Cecil Reginald BURCH, Ph.D. (*Bristol*).

Associate Member to Member.—George John Russell BURTON, B.E. (*Mount Isa*); Robert William Alan HANSEL, A.C.S.M. (*Harrogate*); Norman Kynaston KITTO, A.C.S.M., A.R.I.C.S. (*Redruth*); Eric James LANGEVAD, B.E., F.S.A.S.M. (*Kilembe*); Derek George Warner NORRIS, A.R.S.M., B.Sc. (*Fundao, Portugal*); Reginald Clive PARGETER, A.R.S.M., B.Sc. (*London*); Donald John SIMMONS, A.R.S.M., B.Sc. (*West Drayton*); Charles William STURGEON (*Chingola*); James Francis Alexander TAYLOR, B.Sc., B.E., M.S. (*Kilembe*).

Associate Member.—Lionel Meyer BEAR, B.Sc. (*Nicosia*); Michael Henry BUCKENHAM, B.E. (*Dunedin, N. Zealand*); Christopher Carleton John BURTON, B.Sc. (*Mufulira*); Frank CHILTON, B.Sc. (*Luanshya*); Adrian Harry DEBNAM, Ph.D. (*Ottawa*); Edward DOUGLAS, B.Sc. (*Welwyn*); John Lynn EVANS, B.A. (*Obuasi*); Michael Gilbert FARRAND, B.A., B.Sc. (*Accra*); Archibald William FLETCHER, B.Sc., A.R.I.C. (*Stevenage*); Brian Harry Ignatius HONAN, A.R.S.M., B.Sc. (*Bancroft*); Charles James HUGHES, Ph.D., M.A. (*Wallasey*); Jack MCFARLANE, B.Sc., B.E. (*Leeds*); Petrus Johannes PIENAAR, Ph.D., M.Sc. (*Kitwe*); Olav MELLGREN, Sc.D. (*London*); Thomas Martin TEMPLETON (*Luanshya*).

Affiliate or Student to Associate Member.—Ahmed AZIZUDDIN, B.E. (*Johore Bahru*); Trevor Terence BESTOW, B.Sc. (*Nairobi*); Roger James Casalis DE PURY, A.R.S.M., B.Sc. (*Luanshya*); Geoffrey Alan COX, A.R.S.M., B.Sc. (*St. Agnes*); Keri EVANS, B.Sc. (*Luanshya*); Bernard Godfrey FISK, A.R.S.M., B.Sc. (*Kitwe*); Robert MCDONALD, A.H.-W.C. (*Glenrothes*); Ronald William Kenneth MACKENZIE, B.Sc. (*Luanshya*); Michael Palmer O'CONNOR (*Welkom*); Abdul Halim Bin Bahar RASIP, A.R.S.M., B.Sc. (*Trengganu*); Barrie Millard SCOTT, B.Sc. (*Hythe*); Maung Ko Ko THAN, A.C.S.M., B.Sc. (*Rangoon*); Gerald Edward WILFORD, Ph.D. (*Brunei*); Edward Kojo-Esson WILLIAMS, A.C.S.M. (*New York*).

Affiliate.—Eric ADAMSON, B.Sc. (*Mufulira*); John Edward SHENNAN (*Musoma*); John William YATES-WATSON (*Beaconsfield*).

Student.—John ABRAHAMSEN (*Edinburgh*); Ralph Leslie ALLEN (*Southsea*); Richard Owen BURT (*Luton*); John Y. COLE, M.Sc. (*Oakland, California*); David Anthony LANGTRY (*Woodley*); John Neville PORTER (*Akwata, Ghana*); Bhupathi Jagannadha RAO (*Camborne*); Cornelis Josephus Frijda SMIT (*Amsterdam*); Trevor John STANWELL (*Thornton-le-Moors*); Tham Weng SEK, A.O.S.M., B.E. (*Taiping*).

Metal Markets

During July [1]

Copper.—During July copper prices moved rather grudgingly towards a stronger tone [2] in the face of a number of developments on the labour front, but particularly in Chile. Progressive developments there during the month have been the passing of a law making a strike at the Anaconda and Potrerillos facilities legal, the declaration by the unions that any such strike would be accompanied by a solidarity strike at El Teniente and Chuquicamata, and, finally, a report that negotiations between the copper companies and the unions have been broken off. However, three hours before the strike deadline a ten-day postponement of the strike was agreed.

On other fronts the threatened strike against Kennecott Copper by the big international Mine Mill union was averted when settlement was reached, but a settlement with the United Steelworkers, who are quite influential in Kennecott plants, has still to be negotiated. All this has taken place against a statistical background which is itself paradoxical, as many major world producers are still restricting production to help square the position (this has resulted in the almost permanent shortage of electro wire bars becoming more pronounced again, with an increase in premiums paid), yet there is still a basic oversupply of the metal big enough to offset all these points of bullish significance.

U.K. May copper consumption was 58,522 tons (44,083 tons refined). Primary refined copper production was 11,558 tons and secondary refined 8,522 tons—both a little higher. Stocks of blister copper were slightly lower at 18,455 tons, but refined stocks rose to 110,021 tons.

Tin.—Although it became obvious after the first flush of enthusiasm when tin prices broke through the £880 a ton barrier that there would be a period of reaction before a solid upward trend developed, the extent to which prices receded in the early part of July [1] surprised quite a few people and they have been much relieved by the stronger trend of prices in the latter part of the month which has brought them back within sight of the levels achieved after the first break through. Both the weakening and the subsequent strengthening have their reasonable explanations, the former being attributable to a spate of adverse industrial reports and leading up to the U.K. Chancellor of the Exchequer's announcement of moves to stiffen the economy. Subsequently the market has been influenced by a number of points including the re-appearance of some consumer buying. This has been the object of

[1] Recent prices, pp. 72, 108.
[2] See Table, p. 108.

[1] See Table, p. 108.

particular attention because many consumers had bought ahead of their requirements when they participated in the final clear-out of Buffer Stock holdings. Another point to which the market has been sensitive has been the declining tendency of stocks in L.M.E. warehouses as, of course, new tin is not being put on warrant but is going directly to consumers. Meanwhile it needs also to be remembered that part of the metal shown as lying in L.M.E. warehouses is not available for day-to-day market operations because the holders of this metal bought from the Buffer Stock for purely speculative purposes and they are naturally anxious to hold for the best possible prices for their metal. That a better price for tin will eventually supervene is not in any doubt, as production reports continue to reflect the truth of the earlier prediction that there is bound to be a deficit of production in relation to consumption this year.

U.K. tin consumption in May was 1,807 tons, while production was 2,256 tons and stocks decreased gently to 11,330 tons.

Lead.—Lead has been a particularly uninteresting market again in July.[1] Although there is still no official news about the barter arrangements which the U.S. Government is believed to have concluded with the Canadian and Australian producers being implemented, the belief that this will eventually be done continues to provide the more or less complete balance for any disappointment that might otherwise be felt at the delays which have occurred, since a fairly solid commitment to arrange these deals was accepted by the U.S. authorities back in April. As has become a cyclical feature of the market prices began to edge gently upwards, partly because they had fallen to an exceptionally depressed level and partly because sentiment was favourable in other metals, but as soon as a worthwhile level was reached a significant quantity of metal—in the context of the thin London market—was brought out and reversed the improvement.

U.K. lead consumption in May amounted to 31,117 tons, so that the total for 1961 to date is still quite close to the figure in the same period of 1960. Meanwhile production of English refined lead was 7,317 tons and stocks of imported lead dropped slightly to 57,035 tons, while those of English lead were somewhat higher at 9,207 tons.

Zinc.—Like lead, zinc has moved in a conspicuously unexciting fashion in July. It should perhaps not be expected that there should be any great excitement in the zinc market in a month in which most works either include their annual holidays or are thinking about them, and in which new developments of basic market significance have been completely absent. However, there began to be a suspicion in the early part of July that the stagnation of prices[1] might be concealing some weakening in the overall zinc situation which was not being reflected. It would be untrue to say that this suspicion has been entirely eliminated and a number of informed observers would still not be surprised to see zinc go lower before the autumn recovery in world economic activity, towards which industrial observers are so keenly looking, presumably brings in its train some solid improvement in the zinc situation.

U.K. zinc consumption in May was 30,085 tons, while production was 7,046 tons. Stocks of zinc increased marginally to 66,680 tons.

Iron and Steel.—July (with August) is traditionally a quiet month for the iron and steel industry because of annual holidays. Last month, however, was greatly different as compared with a year ago when most consumers were anxious to secure as much material as they could to tide them over the holiday period. This July witnessed a further abatement in the pressure for steel and more works were forced to curtail production.

From the supply point of view two factors dominate the picture : Consumers' large stocks and the ability of the works to deliver material at short notice. Before the Chancellor announced his "little Budget" most consumers were in the process of reducing their large stocks and the sharp rise in interest rates will be an even bigger incentive not to tie up capital in the stockyard. Apart from the high Bank Rate Mr. Selwyn Lloyd's medicine will make British industry more cautious about the prospects for trade and the steel industry can hardly expect a lively level of demand in such circumstances. To date the recovery in the motor industry has been disappointing and the strip mills have been operating below their limits. Tinplate, which is another product from the wide strip mills, has improved, particularly in the home market, and mills have been better employed.

The call for standard sections has declined in the past two months or so, but universal beams are still holding up well. The demand for plates, which was very strong at one time, has slackened appreciably. There is no shortage of semi-finished steel, but requirements from the re-rolling industry remain at a subdued rate.

[1] See Table, p. 108.

[1] See Table, p. 108.

In the export market British steel has been doing quite well, but competition remains very intense.

Iron Ore.—As compared with steel U.K. production of pig-iron made a better showing in the first half of the year and as a result consumption of iron ore was maintained at an impressive level. Iron output, however, has been tailing off lately and because of the very heavy ore stocks at the steelworks producers have been slowing down the intake from abroad. Imports of iron ore and concentrates in the first half of 1961 declined by nearly 6% to 7,952,889 tons, from 8,458,137 tons in the same half of 1960.

Aluminium.—Statistics for the U.K. aluminium industry in May of 1961 became available in July. This in itself is an item of news, as for many years past aluminium statistics have lagged steadily behind those for the other metals. Today, however, the figures are compiled and issued by the industry's own organization with a salutary improvement in the speed with which they appear. Unfortunately the May figures were scarcely worth taking the trouble over, as they reflect only too sadly the poor performance of the U.K. semi-fabricating industry this year. Indeed, on a proportionate basis aluminium has fared worse than any other major non-ferrous metal as compared with last year. This news, however, has only marginally damped the traditional optimism of the aluminium world, although at the same time it has spurred it to more intensive efforts on sales.

Highlighting a possible growth in the near future which can be attacked by the aluminium companies on a broad front (in contrast to, say, the motor-car industry where aluminium has made some headway, but necessarily on only a narrow front) a programme of promoting aluminium to architects was launched in July. Sponsored by the British Aluminium Co. the programme nevertheless has an industry-wide basis and is designed to provide every British architect with all the information he could possibly require to help him decide to specify aluminium in architectural applications. Certainly a contrast between the proportionate use in building in the U.K. and the U.S.A. leads to the belief that U.K. use in this field could be usefully increased.

Antimony.—Over the past month the antimony metal and ore markets have remained steady, but the outlook for metal is not particularly brilliant. Latest market news is that the Chinese are pressing their export sales of certain mineral products, particularly antimony regulus. The Russians are also pressing their material, stimulated perhaps by the need to increase their purchases of Chinese. Prices, however, remain at the same level as for June—namely, 60% ore from 26s. to 28s. per unit c.i.f. and U.K. regulus still quoted at £230 per ton and 99·6% at £237 10s. per ton.

Arsenic.—The general position of arsenic has remained fairly dull throughout the last month. The price of metallic arsenic in the U.K. is still held at £400 per ton and of arsenic trioxide at £40 to £45 per ton.

Bismuth.—Following recent trends the bismuth market remains interesting but exceptionally stable. The U.K. price is still nominally 16s. per lb.

Cobalt.—The prospect of a world surplus of cobalt is still apparent for some considerable time forward, but the market has remained steady throughout the month. Contract supplies of metal still change hands within the U.K. at 10s. 9d. per lb. and to others the price remains at 12s.

Cadmium.—The cadmium market has definitely shown signs of improvement of late and indications are that the second half of the year should bring a pick-up in consumption. The current price of cadmium within the U.K. is maintained at 11s. per lb.

Chromium.—The chromium metal market remained unchanged throughout July, the U.K. price range being from 6s. 11d. to 7s. 4d. per lb.

Tantalum.—The tantalum ore market was steady again throughout July although not very active. Prices remained between 1,000s. and 1,200s. per unit c.i.f. for a 60% good ore.

Platinum.—Following the trends of recent months the platinum market has remained steady. Contractual demands continue to be met by the big producers. The U.K. price of £30 5s. per troy oz. remains, but for imported the range is now from £27 10s. to £28, as compared with £27 10s. to £28 5s. a month ago.

Iridium.—As we are now right into the quiet summer months little change is expected. Consequently the market has been very quiet of late and the U.K. price of £20 to £26 15s. per troy oz. has been steadily held.

Palladium.—Palladium has followed its usually routine path throughout the month, and the U.K. price has been maintained at £8 10s. to £9 7s. 6d. per troy oz.

Osmium.—This metal has continued to be quite uninteresting throughout July, the price remaining at £17 to £25 per troy oz.

Tellurium.—Developments in the tellurium market earlier in the month caused the price for sticks to be changed from 40s. per lb. to the

qualification of nominal. It appeared that the regular customers of the usual suppliers found no difficulty in obtaining the material at the quoted prices but it was not available to anyone else. The market is very tightly supplied and seems as if it will remain so. The long-term prospect for this market appears bright, in the belief that substantial quantities of tellurium will be needed to meet the future demands for tellurides.

Tungsten.—After a period of total inactivity, during which the price was held at 128s. 6d. to 132s. 6d., the market changed towards the end of the month and a significant tonnage was disposed of at rather discouraging prices. Consequently the price range changed and is currently quoted at 128s. to 132s. per unit. A recent development is that China is pressing the direct export of tungsten ore to countries other than those in the Communist bloc.

Nickel.—Following the price rise to £660 at the end of last month the consumption of nickel has remained steady throughout July. Latest news is that the U.K. Iron and Steel Board has increased the maximum prices of most nickel-bearing alloy and stainless steels following the recent price rise in nickel.

Chrome Ore.—The market has remained healthy throughout July. However, reports from Southern Rhodesia tell of an impending railway bottleneck, the railways having recently been refusing to carry certain parcels; consequently there have been some delays in deliveries. Latest news is that some 60,000 tons to 65,000 tons of Turkish refractory chrome ore has been sold to the U.S.A. at a price of $28 per ton f.o.b. for delivery over two years. Some reports say this is a 46% ore and over half will be delivered in the first year, but these points are doubtful. The official Turkish export price for metallurgical remains at $30 per ton f.o.b., while Rhodesian metallurgical remains at £15 5s. per ton c.i.f.

Molybdenum.—The market for molybdenite has remained strong throughout July, the unit price remaining at the new level of 10s. per lb. Mo f.o.b. Following the earlier ore price increase U.K. prices for molybdenum products were advanced effective July 31.

Manganese.—Prices for this material are still quoted at 68d. to 71d. per long ton unit of Mn c.i.f. The market has remained uneventful and appears as if it will continue to do so.

Tin, Copper, Lead, and Zinc Prices

Tin, minimum 99·75%; Copper, electro; Lead, minimum 99·75%; and Zinc, minimum 98% per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
July 11	919 0	928 10	230 12½	234 17½	64 1¼	65 8¾	77 3¾	78 6¼
12	915 0	925 10	229 12½	233 17½	63 13¾	65 3¾	77 3¾	78 6¼
13	912 0	924 10	228 2½	233 2½	64 3¾	65 8¾	77 3¾	78 11¼
14	911 0	922 10	227 15	232 2½	64 12½	66 1¼	77 10	78 13¾
17	908 0	918 5	227 17½	232 2½	65 1¼	66 11¼	77 18¾	79 3¾
18	907 0	917 10	227 17½	231 17½	64 12½	65 17½	77 12½	78 18¾
19	909 0	918 10	227 12½	230 12½	64 12½	65 16¼	77 13¾	78 18¾
20	913 0	923 5	228 5	231 12½	65 2½	66 8¾	77 17½	79 5
21	913 0	923 15	231 2½	234 2½	65 3¾	66 8¾	78 1¼	79 6¼
24	910 0	921 10	230 7½	233 12½	65 7½	66 13¾	78 5	79 6¼
25	915 0	924 10	231 2½	234 2½	66 0	66 18¾	78 12½	79 11¼
26	910 0	924 10	228 17½	232 12½	65 1¼	66 1¼	78 1¼	79 3¾
27	915 10	929 5	229 12½	233 7½	65 1¼	66 3¾	78 2½	79 3¾
28	921 0	933 15	230 17½	234 7½	65 1¼	66 6¼	78 3¾	79 6¼
31	923 0	935 15	233 17½	236 12½	65 18¾	66 16¼	78 11¼	79 11¼
Aug. 1	920 0	932 10	230 2½	233 2½	65 2½	66 3¾	77 18¾	78 13¾
2	921 10	932 5	230 2½	232 17½	65 1¼	66 1¼	77 17½	78 15
3	921 0	932 10	229 12½	232 12½	64 18¾	66 1¼	78 1¼	78 13¾
4	925 0	934 15	229 12½	233 5	64 13¾	66 1¼	77 7½	78 1¼
7	—	—	—	—	—	—	—	—
8	924 0	935 15	231 0	234 12½	64 18¾	66 3¾	77 3¾	78 3¾
9	923 0	934 15	229 7½	233 2½	64 13¾	66 1¼	77 18¾	77 18¾
10	925 0	936 5	229 17½	233 15	64 10	66 1¼	76 16¼	77 16¼

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	June		July	
	Treated Tons	Yield Oz.†	Treated Tons	Yield Oz.*
Blyvooruitzicht	142,000	88,761	138,000	86,324
Brakpan	142,000	18,577	146,000	18,605
Buffelsfontein‡	152,000	66,458	152,000	66,439
City Deep	117,000	24,045	121,000	23,636
Cons. Main Reef	43,000	8,210	39,000	8,974
Crown Mines	176,000	30,556	178,000	31,131
Daggafontein	227,000	45,871	228,000	46,008
Dominion Reefs	44,000	490	40,000	240
Doornfontein‡	120,000	51,012	125,000	53,500
D'rb'n Roodeport Deep	194,000	36,615	200,000	37,024
East Champ D'Or‡	12,500	241	12,500	351
East Daggafontein	107,500	18,436	108,000	18,421
East Geduld	125,000	35,125	124,000	34,844
East Rand P.M.	240,000	55,295	230,000	55,449
Eastern Transvaal Consol	19,800	5,688	20,400	5,898
Ellaton‡	24,000	5,631	23,000	5,468
Freddies Consol	65,000	12,927	65,000	13,512
Free State Geduld	98,500	85,942	99,500	86,565
Free State Saaiplaas	57,000	29,517	60,000	16,445
Geduld	80,000	12,882	80,000	12,805
Government G.M. Areas‡	34,000	6,652	34,000	6,268
Grootvlei Proprietary	218,000	45,142	220,000	45,499
Harmony Gold Mining	196,000	78,897	202,000	81,302
Hartebeestfontein‡	136,000	62,235	136,000	62,560
Libanon	118,000	29,517	119,000	30,255
Loraine	85,000	25,288	85,000	26,350
Luipaards Vlei‡	110,000	13,646	110,000	13,831
Marievale Consolidated	99,000	23,760	99,000	23,760
Modderfontein East	59,000	6,310	61,000	6,360
New Kleinfontein	72,000	10,081	69,000	10,027
New Klerksdorp‡	—	—	—	—
President Brand	128,000	100,135	130,000	100,866
President Steyn	110,000	41,177	110,000	41,421
Rand Leases	190,000	25,650	192,000	26,112
Randfontein‡	156,000	9,388	136,000	9,996
Rietfontein Consolid't'd	12,000	3,181	12,000	3,170
Robinson Deep	44,500	9,700	45,000	9,929
Rose Deep	23,000	4,158	23,000	4,072
St. Helena Gold Mines	187,000	65,459	188,000	65,806
Simmer and Jack	70,000	12,579	71,000	12,384
S. African Land and Ex.	112,000	22,441	111,000	22,255
S. Roodepoort M.R.	30,000	7,170	30,000	7,250
Spaarwater Gold	11,200	3,567	11,200	3,563
Springs	94,000	13,630	94,000	13,883
Stilfontein Gold Mining‡	179,000	80,600	182,000	81,900
Sub Nigel	66,500	15,036	66,500	15,022
Transvaal G.M. Estates	—	—	—	—
Vaal Reefs‡	107,000	50,023	114,000	53,295
Van Dyk Consolidated	74,000	11,472	74,000	11,348
Venterspost Gold	126,000	37,485	127,000	38,227
Village Main Reef	35,600	3,951	36,800	4,324
Virginia O.F.S.‡	142,000	28,294	143,000	28,457
Vlakfontein	53,000	19,570	53,000	19,597
Vogelstruisbult‡	80,000	17,148	80,000	17,244
Welkom Gold Mining	103,500	32,797	104,000	32,607
West Driefontein‡	175,000	137,812	180,000	140,402
West Rand Consol.‡	214,000	22,489	219,000	22,463
Western Holdings	175,000	120,313	175,000	121,222
Western Reefs	155,000	40,184	155,000	45,184
Winkelhaak	96,000	32,640	96,000	32,640
Witwatersrand Nigel	20,000	4,274	19,300	4,273

* 251s. 8d. † 250s. 3d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION *

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
June, 1960	17,968,300	73 9	46 3	27 6	31,941,743
July	—	—	—	—	—
August	—	—	—	—	—
Sept.	18,103,100	74 0	46 4	27 8	32,201,685
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	17,272,800	76 2	47 0	29 2	33,039,583
Jan., 1961	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	17,858,100	—	—	—	31,924,315
April	—	—	—	—	—
May	—	—	—	—	—
June	—	—	—	—	65,772,460†

* 3 Months. † R

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
August, 1960	1,778,711	36,777	1,815,488
September	1,774,967	35,352	1,810,319
October	1,777,495	35,967	1,813,462
November	1,775,624	36,159	1,811,783
December	1,744,406	34,044	1,778,450
January, 1961	1,785,614	34,407	1,820,021
February	1,759,373	32,046	1,791,419
March	1,837,280	38,843	1,876,123
April	1,837,511	29,437	1,866,948
May	1,885,415	42,062	1,927,477
June	1,887,594	35,858	1,923,452
July	—	—	—

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
November 30, 1960	367,658	33,052	400,710
December 31	364,407	32,791	397,198
January 31, 1961	384,816	33,513	418,329
February 28	396,533	33,577	430,110
March 31	398,626	33,736	432,362
April 30	398,012	34,005	432,017
May 31	396,437	33,587	430,024
June 30	392,591	33,180	425,771
July	—	—	—

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To July 22		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	—	—	—
Electrolytic Zinc	19,591	970	5,940
Lake George	17,084	1,043	2,214
Mount Isa Mines**	44,823	2,940†	3,816
New Broken Hill	50,130	5,740	11,211
North Broken Hill	28,338	5,121	5,674
Zinc Corp.	54,330	7,332	10,187
Rhodesia Broken Hill*	—	3,812†	7,501†

* 3 Months, ** Copper 3,220 tons blister; 3,370 tons concs.; † Metal

RHODESIAN GOLD OUTPUTS

	June		July	
	Tons	Oz.	Tons	Oz.
Cam and Motor	—	—	—	—
Falcon Mines	22,200	4,351	—	—
Globe and Phœnix	—	—	—	—
Motapa Gold Mining	—	—	—	—
Mazoe	2,814	—	—	—
Coronation Syndicate	11,300	—	—	—
Phœnix Prince*	35,830	3,247	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	June		July	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	—	—	—	—
Ariston Gold Mines	—	—	—	—
Ashanti Goldfields	38,500	32,750	38,500	32,500
Bibiani	—	—	—	—
Bremang	—	—	—	—
Ghana Main Reef	—	—	—	—
Konongo	7,730	4,278	8,010	4,321
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1960		1961	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	44,902	29,711	47,673	22,101
February	45,754	29,865	44,164	13,250
March	45,309	29,656	52,507	7,256
April	48,607	6,847	50,090	7,992
May	47,542	62,912	—	—
June	45,884	34,298	—	—
July	44,865	33,323	—	—
August	48,284	28,931	—	—
September	48,865	38,951	—	—
October	47,473	37,308	—	—
November	46,439	33,896	—	—
December	48,778	26,327	—	—

WESTRALIAN GOLD PRODUCTION

	1959	1960	1961
	Oz.	Oz.	Oz.
January	63,924	64,794	62,434
February	65,035	66,789	73,271
March	65,408	61,941	69,360
April	62,686	65,373	62,569
May	64,184	66,682	66,352
June	74,590	74,902	81,562
July	78,974	67,623	—
August	68,546	67,466	—
September	66,501	68,794	—
October	70,427	67,310	—
November	68,858	107,815	—
December	117,474	76,269	—
Total	861,122	855,758	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To June 20		To July 18	
	Tons	Oz.	Tons	Oz.
Central Norseman	14,019	7,444	14,011	7,580
Gold Mines of Kalgoorlie	40,929	9,559	41,577	11,058
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	33,675	5,383	33,883	5,045
Lake View and Star*	—	—	—	—
North Kalgurli	29,345	6,314	—	—
Sons of Gwalia	11,868	2,897	—	—
Mount Morgan	—	4,315	—	5,609

* 3 Months.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
February, 1960	755,569	222,484	35,003	7,446,848
March	804,309	229,457	37,202	7,646,044
April	779,487	218,393	42,997	7,426,262
May	784,391	225,550	32,174	7,765,153
June	791,488	223,833	40,765	7,756,490
July	779,426	222,179	37,002	7,964,968
August	712,792	202,025	35,722	6,883,254
September	772,984	208,019	29,251	7,114,785
October	805,753	228,914	33,808	7,860,787
November	785,133	230,377	31,149	7,917,352
December	783,501	229,639	37,560	8,020,961
January, 1961	804,026	227,771	27,776	7,901,743
February	737,859	214,763	33,291	7,465,046
March	814,951	234,228	34,181	8,128,958
April	770,931	225,836	32,949	7,842,394
May	794,700	233,162	34,071	8,088,356

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	June		July	
	Tons	Oz.	Tons	Oz.
Clutha River	—	648	—	543
Lampa (Peru)†	—	41,448	—	—
New Guinea Goldfields	3,819	940	—	—
Yukon Consol.	—	$274,000	—	$368,000

† Oz. Silver : Copper, 111 tons ; 135 tons.

AUSTRALIAN BASE-METAL OUTPUTS

Period	Concentrate Production (Long Tons)		
	Zinc	Copper (a)	Lead
1960	290,596	104,889	297,510
Provisional 1960—January	15,070	8,169	15,540
February	26,716	8,265	26,437
March	27,535	9,680	26,146
April	23,759	9,548	21,279
May	—	—	—
June	—	—	—
July	—	—	—
August	—	—	—
September	—	—	—
October	—	—	—
November	—	—	—
December	—	—	—

(a) includes Cu content of direct smelting ore.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	May	June	July
Ampat Tin	55	75	64
Austral Amalgamated	169	—	—
Ayer Hitam	—	571*	—
Berjuntai	322	301½	364
Chenderiang	—	65*	—
Gopeng Consolidated	—	471*	—
Hong Fatt (Sungei Besi)	—	—	—
Hongkong Tin	—	192*	—
Idris Hydraulic	—	65*	—
Ipoh	3½	11½	—
Kampong Lanjut	161	174	146½
Kamunting	179	171	177
Kent (F.M.S.)	—	95*	—
Kepong	—	147*	—
Killinghall	—	60*	—
Kinta Kellas	10	14½	13
Kramat	37	43	41
Kuala Kampar	147½	108	105½
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Larut	27	21½	19
Lower Perak	125	121	133
Malayan	—	630½*	213½
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	632*	—
Pengkalen	—	146*	—
Petaling Tin	69½	81	103
Rahman Hydraulic	32	—	—
Rambutan	—	55*	—
Rantau	84	72	79½
Renong	—	272*	—
Selayang	—	4*	—
Siamese Tin Syndicate (Malaya)	29	5	—
Southern Kinta	408	426	454
Southern Malayan	—	859*	335
Southern Tronoh	—	—	—
Sungei Besi	—	372*	—
Sungei Kinta	—	—	—
Sungei Way	—	415*	—
Taiping Consolidated	—	28	32
Tanjong	—	131*	—
Tekka	—	—	—
Temoh	—	—	—
Tongkah Harbour	—	130	148
Tronoh	—	1131*	—

* 3 Months.

NIGERIAN MINE OUTPUTS (TONS)

	Apr.	May.
Cassiterite	788	685
Columbite	162	159
Felspar	—	—
Gold*	48	69
Kaolin	—	—
Lead Ore	—	—
Limestone	35,574	37,083
Monazite	1	1
Oil	—	166,895
Tantalite	1	—
Thorite	—	—
Tin Metal	101	65
Wolfram	—	—
Zircon	55	82

* Oz.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	June		July	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines	431	77	—	—
Anglo-Burma Tin*	—	—	—	—
Bangrin	26	—	—	—
Beralt	3	175†	3	180†
Bisichi	39	47½	—	—
Ex-Lands Nigeria	40	—	50	—
Fabulosa	59	—	—	—
Geevor	58	—	—	—
Gold and Base Metal	57	3	—	—
Jantar Nigeria	9½	28	—	—
Jos Tin	9	—	—	—
Kaduna Prospectors	4	—	6	—
Kaduna Syndicate	19	—	29	—
Katu Tin	6	—	—	—
Keffi Tin	—	—	—	—
London Nigerian Mines	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	—	—	—	—
Naraguta Karama	3	—	—	—
Naraguta Tin	—	—	—	—
Ribon Valley (Nigeria)	—	—	—	—
Siamese Tin Syndicate	118	—	—	—
South Bukeru	—	—	—	—
South Crofty	—	—	—	—
Tavoy Tin	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	11	¼	—	—

* 3 Months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

May, 1961.

Gold	1,920,065 oz.
Silver	200,858 oz.
Diamonds	96,640 carats.*
Coal	3,892,083 tons.
Copper	(*a*) 25 tons in matte and copper-gold concentrates. (*b*) 5,179 tons of 99·05%.
Tin	253 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	16,956 tons.
Chrome Ore	95,141 tons.
Manganese Ore	141,464 tons.
Lead Concs.	11 tons.

* *April, 1961.*

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		May	June
Iron Ore	tons	1,483,898	1,519,042
Manganese Ore	,,	33,305	48,838
Iron and Steel	,,	47,594	41,740
Iron Pyrites	,,	28,969	27,938
Copper Metal	,,	48,566	58,604
Tin Ore	,,	6,573	3,809
Tin Metal	,,	191	80
Lead	,,	13,148	19,373
Zinc Ore and Conc.	,,	29,617	15,036
Zinc	,,	15,551	13,737
Tungsten Ores	,,	462	594
Crome Ore	,,	27,931	11,731
Bauxite	,,	32,063	38,973
Antimony Ore and Concs.	,,	1,814	1,077
Titanium Ore	,,	23,381	27,869
Zirconium Ores and Concs.	,,	3,066	1,080
Tantalite/Columbite	,,	67	20
Sulphur	,,	57,136	40,707
Barytes	,,	2,872	4,020
Asbestos	,,	21,728	22,587
Magnesite	,,	21,118	14,713
Mica	,,	905	801
Graphite	,,	1,677	485
Mineral Phosphates	,,	110,409	97,304
Molybdenum Ore	,,	903	544
Silicon	,,	755	591
Nickel	cwt.	55,398	24,987
Aluminium	,,	505,244	537,503
Mercury	lb.	200,185	245,385
Bismuth	,,	96,120	—
Cadmium	,,	177,318	221,449
Cobalt and Cobalt Alloys	,,	549,035	238,953
Selenium	,,	25,205	26,601
Petroleum Crude	1,000 gal.	1,171,069	1,009,643

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	104	0	0
,, ,, 80% Technical	,,	94	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	5	0
Ammonia, Anhydrous	per lb.		1	6
Ammonium Carbonate	per ton	59	0	0
,, Chloride	,,	30	2	6
,, Nitrate	,,	36	5	0
Antimony Sulphide, golden	per lb.		4	4
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate 98–99%	,,	42	0	0
,, Chloride	,,	45	0	0
Barytes (Bleached)	,,	20	0	0
Benzene	per gal.		5	6
Bleaching Powder, 35% Cl.	per ton	30	7	6
Borax	,,	46	10	0
Boric Acid, Comml.	,,	77	10	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	17	0	0
Carbolic Acid, crystals	per lb.		1	2
Carbon Bisulphide	per ton	62	10	0
Chromic Acid	,,	245	0	0
Citric Acid	per cwt.	8	14	0
Copper Sulphate	per ton	78	0	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	3
Cresylic Acid, refined	,,		8	2
Hydrochloric Acid 28° Tw.	per carboy		13	6
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iodine	per kilo		17	4
Iron Sulphate	per ton	3	5	0
Lead, Carbonate, white	,,	112	5	0
,, Nitrate	,,	114	0	0
,, Oxide, Litharge	,,	101	5	0
,, Red	,,	99	5	0
Lime Acetate, brown	,,	40	0	0
Lithopone	,,	57	10	0
Magnesite, Calcined	,,	20	0	0
,, Raw	,,	13	0	0
Magnesium Chloride	,,	20	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		5	10½
Nickel Sulphate	per ton	207	0	0
Nitric Acid, 70° Tw.	,,	35	0	0
Oxalic Acid	,,	132	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Potassium Bichromate	per ton	131	6	8
,, Bromide	per lb.		2	6
,, Carbonate (hydrated)	per ton	72	10	0
,, Chloride	,,	21	0	0
,, Iodide	per kilo		19	3
,, Hydrate (Caustic) flake	per ton	92	0	0
,, Nitrate	per cwt.	3	10	0
,, Permanganate	,,	10	3	0
,, Sulphate, 50%	per ton	21	4	6
Sodium Acetate	,,	63	0	0
,, Arsenate, 58–60%	,,	Nominal		
,, Bicarbonate	,,	18	0	0
,, Bichromate	,,	109	13	4
,, Carbonate (Soda Ash) 58%	,,	16	0	0
,, Chlorate	per ton	90	0	0
,, Cyanide	per cwt.	6	18	10
,, Hydrate, 98/99% solid	per ton	35	6	6
,, Hyposulphite, Comml.	,,	35	0	0
,, Nitrate, Comml.	,,	Nominal		
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0½
,, Silicate	per ton	16	0	0
,, Sulphate (Glauber's Salt)	,,	12	5	0
,, ,, (Salt-Cake)	,,	10	0	0
,, Sulphide, flakes, 60/62%	,,	40	12	6
,, Sulphite, Comml.	,,	27	15	0
Sulphur, American, Rock (Truckload)	,,	13	0	0
,, Ground, Crude	,,	17	10	0
Sulphuric Acid, 168° Tw.	,,	12	0	0
,, ,, free from Arsenic, 140° Tw.	,,	8	10	0
Superphosphate of Lime, 18% P_2O_5	,,	13	15	0
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	172	0	0
,, White, 25%	,,	85	0	0
Zinc Chloride	,,	95	0	0
,, Dust, 95/97% (4-ton lots)	,,	121	10	0
,, Oxide	,,	95	10	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	July 10, 1961 £ s. d.	Aug. 8, 1961 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	2 1 3	2 1 6
Blyvooruitzicht (2s. 6d.)	1 3 6	1 5 6
Bracken (10s.)	18 6	1 0 9
Brakpan (3d.)	3 0	3 6
Buffelsfontein (10s.)	1 13 3	1 12 6
City Deep	12 3	13 6
Consolidated Main Reef	12 6	13 0
Crown Mines (10s.)	19 3	19 3
Daggafontein (5s.)	15 6	18 6
Dominion Reefs (5s.)	16 0	18 9
Doornfontein (10s.)	1 5 3	1 6 6
Durban Roodepoort Deep (10s.)	1 4 3	1 5 0
East Champ d'Or (2s. 6d.)	1 6	1 9
East Daggafontein (10s.)	7 6	9 0
East Geduld (4s.)	13 0	14 3
East Rand Ext. (5s.)	13 3	16 9
East Rand Proprietary (10s.)	1 2 3	1 5 3
Freddies Consol.	1 3	1 6
Free State Dev. (5s.)	3 3	3 3
Free State Geduld (5s.)	3 17 6	3 17 6
Free State Saaiplaas (10s.)	6 3	4 0
Geduld	1 18 3	2 3 0
Government Gold Mining Areas (3d.)	1 6	1 6
Grootvlei (5s.)	16 0	17 3
Harmony (5s.)	1 0 3	1 2 0
Hartebeestfontein (10s.)	2 1 3	2 1 3
Libanon (10s.)	11 3	13 3
Loraine (10s.)	16 0	17 3
Luipaards Vlei (2s.)	7 6	7 6
Marievale (10s.)	1 3 9	1 3 6
Modderfontein B (3d.)	1 3	1 3
Modderfontein East	7 0	7 0
New Kleinfontein	4 0	4 0
New Pioneer (5s.)	1 3 3	1 7 6
New State Areas (15s. 6d.)	6	6
President Brand (5s.)	2 7 6	2 13 3
President Steyn (5s.)	13 9	15 3
Rand Leases (9s. 3d.)	3 6	3 9
Randfontein	15 9	17 6
Rietfontein (3d.)	2 6	2 6
Robinson Deep (3d.)	4 0	4 0
Rose Deep (3d.)	5 6	5 6
St. Helena (10s.)	2 14 9	2 19 3
Simmer and Jack (1s. 6d.)	9	9
South African Land (3s. 6d.)	12 3	13 3
Springs (3d.)	1 0	1 0
Stilfontein (5s.)	1 6 9	1 7 0
Sub Nigel (3d.)	6 9	6 9
Vaal Reefs (5s.)	1 17 6	1 17 6
Van Dyk (3d.)	1 6	1 3
Venterspost (10s.)	16 0	19 3
Virginia (5s.)	2 6	2 6
Vlakfontein (10s.)	14 3	15 3
Vogelstruisbult (3d.)	3 3	3 3
Welkom (5s.)	10 9	11 0
West Driefontein (10s.)	3 13 9	3 18 9
West Rand Consolidated (10s.)	14 6	14 9
West Witwatersrand Areas (2s. 6d.)	2 7 3	2 10 0
Western Holdings (5s.)	5 9 0	6 2 6
Western Reefs (5s.)	1 2 3	1 4 0
Winkelhaak (10s.)	19 3	18 6
Witwatersrand Nigel (2s. 6d.)	6	6
Zandpan (10s.)	7 6	7 6
RHODESIA:		
Cam and Motor (2s. 6d.)	—	—
Chicago-Gaika (10s.)	12 6	12 6
Coronation (2s. 6d.)	3 6	3 6
Falcon (5s.)	7 0	7 6
Globe and Phœnix (5s.)	1 7 6	1 10 0
Motapa (5s.)	—	—
GHANA:		
Amalgamated Banket (3s.)	—	—
Ariston Gold (3s. 6d.)	—	—
Ashanti Goldfields (4s.)	13 0	12 9
Bibiani (4s.)	—	—
Bremang Gold Dredging (5s.)	—	—
Ghana Main Reef (5s.)	—	—
Konongo (2s.)	1 0	1 0
Kwahu (2s.)	4 6	4 3
Offin River (2s. 6d.)	1 9	1 9
Western Selection (5s.)	4 3	3 6
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	1 6	2 0
Gold Mines of Kalgoorlie (10s.)	8 9	9 6
Great Boulder Propriet'y (2s.), W.A.	11 6	12 3
Lake View and Star (4s.), W.A.	1 4 3	1 4 9
Mount Morgan (10s.), Q.	11 6	12 3
New Guinea Gold (4s. 3d.)	1 3	1 3
North Kalgurli (1912) (2s.), W.A.	9 6	10 6
Sons of Gwalia (10s.), W.A.	3 0	2 9
Western Mining (5s.), W.A.	16 9	1 1 9

	July 10, 1961 £ s. d.	Aug. 8, 1961 £ s. d.
MISCELLANEOUS:		
Fresnillo ($1·00)	1 15 0	1 16 3
Kentan Gold Areas	17 6	18 3
St. John d'el Rey, Brazil	4 17 6	4 6 3
Yukon Consolidated ($1)	3 3	3 4½
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	12 3	13 6
Esperanza (2s. 6d.), Cyprus	1 3	1 9
Indian (2s.)	6 0	5 9
MTD (Mangula) (5s.)	6 9	7 0
Messina (5s.), Transvaal	11 6	13 9
Mount Lyell (5s.), Tasmania	6 3	6 0
Nchanga Consolidated, N. Rhodesia	2 3 3	2 7 3
Rhokana Corporation, N. Rhodesia	2 1 6	2 7 3
Roan Antelope (5s.), N. Rhodesia	5 3	5 3
Tanganyika Concessions (10s.)	1 2 3	1 1 6
LEAD-ZINC:		
Broken Hill South (1s.), N.S.W.	11 0	13 6
Burma Mines (3s. 6d.)	1 0	1 9
Consol. Zinc Corp. Ord.	3 7 0	3 13 9
Lake George (5s.), N.S.W.	3 0	3 0
Mount Isa, Queensland (5s. Aust.)	2 12 6	2 14 6
New Broken Hill (5s.), N.S.W.	2 11 3	2 11 0
North Broken Hill (10s.), N.S.W.	16 9	18 6
Rhodesia Broken Hill (5s.)	6 3	7 0
San Francisco (10s.), Mexico	19 3	18 6
TIN:		
Amalgamated Tin (5s.), Nigeria	12 3	11 9
Ampat (4s.), Malaya	17 0	16 3
Ayer Hitam (5s.), Malaya	2 19 0	2 15 0
Beralt (5s.), Portugal	1 7 9	1 6 6
Bisichi (2s. 6d.), Nigeria	5 3	5 0
Ex-Lands (2s.), Nigeria	4 0	4 0
Geevor (5s.), Cornwall	1 4 0	1 4 0
Gold Base Metals (2s. 6d.), Nigeria	1 9	1 9
Hongkong (5s.), Malaya	1 7 0	1 5 6
Jantar Nigeria (3s.)	5 9	5 9
Kaduna Syndicate (2s.), Nigeria	2 9	2 9
Kamunting (5s.), Malaya	1 1 6	18 9
Malayan Tin Dredging (5s.)	2 7 0	1 19 0
Mawchi Mines (4s.), Burma	1 6	1 3
Naraguta Karama (5s.), Nigeria	9	1 0
Pahang (5s.), Malaya	19 6	18 9
Siamese Synd. (5s.)	1 2 6	1 0 9
South Crofty (5s.), Cornwall	4 9	5 9
Southern Kinta (2s.), Malaya	2 10 0	1 6 6
Southern Malayan (5s.)	1 16 9	1 13 9
Sungei Besi (4s.), Malaya	2 19 6	2 10 0
Sungei Kinta, Malaya	16 0	15 6
Sungei Way (2s. 4d.), Malaya	5 6	5 6
Temoh (7s. 6d.), Malaya	5 3	4 9
Tronoh (5s.), Malaya	4 7 6	3 15 0
United Tin Areas (2s. 6d.), Nigeria	2 0	1 9
DIAMONDS:		
Anglo American Investment	10 15 0	12 2 6
Consol African Selection Trust (5s.)	14 9	15 9
Consolidated of S.W.A. Pref. (10s.)	7 6	8 0
De Beers Deferred (5s.)	6 1 3	6 6 3
FINANCE, Etc.		
African & European (10s.)	2 10 0	2 10 0
Anglo. American Corporation (10s.)	5 11 6	6 5 0
Anglo Transvaal 'A' (5s.)	1 6 6	1 8 9
British South Africa (15s.)	3 1 6	3 4 0
British Tin Investment (10s.)	2 4 0	2 4 9
Broken Hill Proprietary	2 15 9	2 16 9
Camp Bird (10s.)	5 0	5 6
Central Mining	1 11 6	1 14 6
Central Provinces Manganese (10s.)	14 6	14 9
Consolidated Gold Fields	2 4 3	2 13 6
Consolidated Mines Selection (10s.)	1 3 3	1 6 9
Corner House	8 9	9 9
East Rand Consolidated (5s.)	1 6	1 9
Free State Development (5s.)	3 3	3 3
General Exploration O.F.S. (2s. 6d.)	2 6	2 9
General Mining and Finance	3 15 0	3 19 0
Hendersons (4s.)	6 6	7 6
Johannesburg Consolidated	1 16 9	2 2 0
London & Rhod. M. & L. (5s.)	6 6	7 6
London Tin Corporation (4s.)	1 0 3	19 6
Lydenburg Est. (5s.)	5 6	8 9
Marsman Investments (10s.)	2 7½	2 7½
National Mining	1 9	1 9
Rand Mines (5s.)	2 15 0	2 19 0
Rand Selection (5s.)	1 13 0	2 0 0
Rhodesian Anglo American (10s.)	2 12 0	2 17 3
Rhodesian Corporation (5s.)	1 9	2 0
Rhodesian Selection Trust (5s.)	9 3	9 3
Rio Tinto (10s.)	1 15 6	1 14 3
Selection Trust (10s.)	4 6 0	4 19 3
South West Africa Co. (3s. 4d.)	12 6	11 3
Union Corporation (2s. 6d.)	2 3 3	2 11 6
Vereeniging	3 15 0	4 13 9
West Rand Inv. Trust (10s.)	1 18 6	2 5 0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Mining at Rustenburg Platinum

An article in the *Platinum Metals Review* for July, based on a paper presented at the Seventh Commonwealth Mining and Metallurgical Congress by C. B. Beath, R. J. Westwood, and C. A. Cousins, describes the development of operating methods at Rustenburg Platinum Mines, Ltd., and the following notes are reproduced here by kind permission of Johnson, Matthey and Co., Ltd., the publishers.

The authors say that the deposit worked in the two mines forms part of the Merensky Reef Horizon of the Bushveld Igneous Complex. The platinum values are concentrated near the top and bottom contacts of a coarsely-crystalline felspathic pyroxenite which has the characteristics of a pegmatite. Chromite concentrations also occur at these contacts and usually form two thin chrome seams. This pegmatitic pyroxenite is overlain by a pyroxenite band of similar composition but of a less coarsely crystalline structure, which may be referred to as the Merensky pyroxenite. This band grades rapidly at its upper contact into an anorthositic gabbro and this in turn is followed by a zone of mottled anorthosite.

In the Rustenburg mine the Merensky platinum reef averages about a foot in thickness and reaches 2 ft. only in certain limited areas. This narrow width allows the whole pegmatitic pyroxenite together with a portion of both the hanging-wall and foot-wall to be included in the stoping width mined.

At the Union mine the pegmatitic pyroxenite averages some 15 ft. to 18 ft. in thickness. This thickness shows a gradual decrease from over 20 ft. in the north-eastern to less than 10 ft. in the south-western areas of the property. Platinum values are found near both the upper and lower contacts, but in the present workings the values at the upper contact are appreciably higher than those at the lower contact. As the distance between the two potential economic zones is far too great for them to be stoped together and the average tenor of values on the lower zone normally falls below the level of payability, mining is confined to the zone near the upper contact. Platinum values show a very low range of distribution, giving a very even tenor of values. The platinum is partly in the form of native metal, invariably alloyed with iron (ferro-platinum), and partly as the sulphide, arsenide, and sulpharsenides, these latter being in intimate association with sulphides of iron, nickel, and copper.

At the Rustenburg mine the platinum compounds preponderate, while at the Union mine the ferro-platinum forms the major platinum mineral. Associated with the platinum are smaller proportions of the platinum group metals. Sulphides of iron, nickel, and copper are always associated with the platinum. Chromite is also present and the highest platinum values occur in association with this mineral.

The reef mined at Rustenburg consists of a thin chromite-rich layer averaging $\frac{3}{4}$ in. in thickness with, above it, a layer of coarsely-crystalline felspathic pyroxenite about 12-in. in thickness. The lower 9 in. of the Merensky pyroxenite above the reef and the upper 9 in. of the foot-wall anorthosite immediately below the chrome band contain platinum group metal values of small account. The platinum-bearing horizon covers a maximum stoping width of 30 in., the surveyor's measured width in stoping operations having averaged $28\frac{1}{2}$ in. over the past ten years. The strike of the reef is east–west and the dip is at 9° 30′ to the north. The reef strike tends to bend slightly northwards on the western half of the property, in conformity with the curved shape of the mafic zone.

Conditions of regularity of strike, dip, and value have allowed the mine to be laid out in a simple and straightforward manner. The length of strike and the comparative shallowness of the deposit have made possible the rapid development of large areas of ground whenever a demand for platinum arose. Thus the output of the mine has followed world demand very closely.

The upper levels of the mine have been and will be largely worked from an incline and sub-incline haulage system, followed in depth by

Scraping Underground at Rustenburg.

a vertical shaft. There are three vertical shafts in operation on the property, while a fourth will be sunk shortly. All three shafts are comparatively shallow, their depths being 500 ft., 780 ft., and 1,500 ft., respectively, from surface. The west vertical shaft is a three-compartment timbered shaft with two-skip hoisting compartments and a pump-ladderway. It has been in use for the past 12 years, but ore in the area is almost exhausted and this shaft will shortly become an upcast ventilation shaft. The Waterval vertical shaft is a 15-ft. diameter concrete-lined shaft which serves the Waterval stoping area. Five-ton skips, interchangeable with double-decked cages are installed.

The central deep shaft is a four-compartment shaft of "square-rectangular" section, measuring 24½ ft. by 11¼ ft. inside timbers. Single-decked cages capable of carrying 40 persons are installed in the two south compartments. These cages are sufficiently large to accommodate trucks of explosives, mining timber, etc. Skips are of 5-ton capacity and are interchangeable with double-decked cages capable of carrying 40 persons. The choice of the "square-rectangular" shaft section was made for two reasons, to ensure a large volume of air being delivered to the underground workings, and to facilitate the loading of men and material into large-sized cages.

A headgear of comparatively light construction is erected at all three vertical shafts. The ore or waste rock hoisted is tipped into a small headgear bin from which it is led by conveyor either to an ore bin situated over the mine surface haulage railway line or to a waste bin, whence it is taken by self-dumping skip to the waste dump.

A 15° three-compartment sub-incline shaft is now in the course of sinking in the Waterval

area. This shaft will be equipped with two 10-ton skips. Ore and waste will be delivered to their respective passes at the top of the incline and trammed to the Waterval vertical shaft tips by overhead electric locomotive.

Generally, except in the eastern extension area, the haulage of ore underground is by overhead electric locomotives pulling trains of 4-ton hoppers through foot-wall haulages. In the eastern extension area 2-ton diesel locomotives are in use.

Standard working methods ensure the delivery of a product of the highest value to mill at the lowest cost. The regularity of the deposit has made the laying down of these standardized procedures comparatively simple, and has to a large extent eliminated the necessity of having to work round large blocks of unpayable ore. Regularity of dip and strike and freedom from faulting allows stope faces to be carried on a true dip line, which leads to optimum breaking.

The aim in stoping is to advance the face in as straight a line as possible on dip at the lowest possible stoping width compatible with efficient breaking. Shallow gully tracks on strike at 40-ft. centres on dip divide the working face into panels and serve as passage ways to and from the face. The raise-winze connexion becomes the path of the central gully scraper. Ore broken on the face is first washed down and examined by the panel-cleaning native. All foot-wall norite and Merensky pyroxenite of sortable size is picked out and thrown back on to the face scatter-pile. The ore remaining is then shovelled 30 ft. down dip and 10 ft. up dip to the panel track, where it is loaded into $\frac{1}{3}$-ton cars, trammed along the gully track, and tipped into the central gully scraper path. It is then scraped to the stope box connecting the stope to foot-wall haulage, loaded into hopper trains, and delivered to the shaft box or ore pass system.

The ore first treated at Rustenburg was from the oxidized zone. It was soft and friable and was mined by pneumatic picks. A recovery plant was built and started operations in 1930. The ore was ground in ball-mills, with great care to avoid sliming, the pulp went to the concentration section, consisting of James tables and corduroy tables by means of which a rich gravity concentrate was made, and the pulp was finally sent to a flotation section to recover a concentrate. The concentrates recovered by the gravity concentrate section were reconcentrated by dressing on James tables. By repeated dressing they were brought up to a suitable grade which was sent overseas directly to the refiners.

As the mine progressed to deeper mining the proportion of oxide ore milled decreased as operations got into the sulphide zone. Apart from other effects on the metallurgical treatment the sulphide ore reduced the proportion of platinum-group metals recovered in the gravity section. The question has often been discussed as to whether it is advantageous to carry on with the gravity recovery, or whether flotation alone should be relied upon. Apart, however, from the safety factor, that by taking out a rich fraction early in the treatment a slightly lower tailing may be obtained, there is

Drilling in a Reef Drive.

a definite economic advantage in making this product. As the product is high in platinum metals it is sent directly to the refiners, thus avoiding the small but inevitable losses incurred in the further treatment of the flotation concentrates.

The gravity concentrates consist of sperrylite (platinum arsenide), cooperite (platinum sulphide), braggite (platinum-palladium-nickel sulphide), stibio palladinite (palladium antimonide), laurite (ruthenium sulphide), native platinum, native gold, mixed with chalcopyrite, pyrrhotite, pentlandite and other sulphides, with some chromite and graphite.

As a greater proportion of the platinum-group metals was then recovered by flotation, the problem of the treatment of the flotation concentrate arose. The method that was most successful, and is now adopted, was to smelt a nickel-copper matte. Preliminary work was carried out on this method by H. R. Adam at the Government Areas Laboratory, but it was Johnson, Matthey and Co., Ltd., who first successfully used the method on a large scale.

The mill at Rustenburg is on the same site as the original 300-ton-per-day mill, and great care and ingenuity have had to be exercised to extend and modernize it to its present capacity. The ore is first crushed in two jaw-crushers to reduce it to *minus* 6 in., the fines (*minus* 2 in.) being screened out and the coarse washed on vibrating screens and then passed over sorting belts. The coarse ore is then crushed in two Symons standard crushers ; the crushed product from here goes to the ½-in. screens, with the oversize from the ½-in. screens returning to two Symons shorthead crushers in closed circuit with these screens. The washings go to four rake classifiers, the rake product being added to the mill feed product, the classifier overflow going direct to the mill circuit.

Ball-milling is carried out in two stages—primary and secondary. There is a total of 22 mills, including the original four mills installed in 1932. The mills are in closed circuit with hydrocyclone classifiers, which give much sharper separations.

Gravity concentration is by means of corduroy tables, which so far have proved the best practical means of recovering the fine platinum minerals. The corduroy concentrate is dressed on an elaborate system of James tables up to a final concentrate, which is sent directly to the refiners.

The tailings from the tables, in a considerably diluted pulp, are returned to the mill circuit, the final pulp from the mill being thickened to flotation destiny in four 75-ft. thickeners fitted with diaphragm pumps. The thickener underflow then goes to the flotation plant. The circuit used is a straighforward rougher-cleaner circuit, with the cleaner tailings returned to the head of the roughers. The thickener underflow is divided into two halves by a splitter in a launder and each half is divided into four streams by revolving distributors. The eight streams are fed to eight banks of 18 cells acting as roughers. A further two banks of 18 cells act as cleaners.

The flotation tailings are sampled by an automatic sampler, thickened in a 250-ft. traction thickener and discharged to the tailings dam. The concentrates are filtered on three 8-ft. by 8-ft. drum filters before passing to the smelter. The small tonnage of concentrates to be smelted initially led inevitably to the use of a small blast-furnace. As the tonnage to be smelted has increased considerably thought has been given to the possible use of reverberatory furnaces, but it has been decided to retain the blast-furnace for smelting. Among other reasons the small blast-furnace is very flexible—it can be stopped and started very readily.

There are four blast-furnaces, 10 ft. long by 36 in. at the tuyères, the number in operation depending on the output required. The furnaces are water jacketed and run with a trapped spout into forehearths. Matte is tapped periodically into ladles and blown in three upright (or Great Falls type) 8-ft. converters. The blowing is carried as far as the white metal stage, and the white metal is poured into moulds. When solid this is broken up in a small jaw crusher, bagged and sent to the refiners. It contains about 74% copper *plus* nickel. The converter slag is cast and returned with other secondary material to the blast-furnaces. The blast-furnace slag is run off continuously, and quenched in a launder with a strong stream of water. The slag granules are raked on to a conveyor belt which conveys them to a storage bin, from which they are dumped.

The converter matte is treated at the Brimsdown works of Johnson, Matthey and Co., Ltd., by the " tops and bottoms " process. The matte is smelted with salt-cake and the copper passes into the " tops " and the nickel into the " bottoms ". The copper sulphide tops are blown to blister copper and cast into anodes for electrolytic refining. The nickel sulphide bottoms are ground and roasted to nickel oxide. This is reduced to metallic nickel with coal in a reverberatory furnace and cast into anodes for electrolytic refining. The anode slime from both the electrolytic sections contains the platinum metals and is then sent to the platinum refinery for chemical processing.

Denbeath Coal Preparation Plant

During the past year the 600 ton-per-hour Denbeath coal preparation plant has been commissioned at Wellesley Colliery, Fife, for the Scottish Division of the National Coal Board. For more than 50 years the larger sizes of coal at Wellesley have been hand-cleaned on a battery of picking belts, but in order to meet the present-day demands of a more exacting market, the new mechanical washer, which includes a Chance sand-flotation cone, has been installed. The new plant relieves a Baum washer, which has been operating for a number of years, of some of the ever-increasing load of small-sized coal. The two washers, now working together, clean the whole of the 600 tons per hour throughput.

The new Chance plant has been designed to handle the 8 in. or 10 in. by 1 in. coal at a maximum rate of 360 tons per hour, while the old washer, now reconditioned, deals with the remaining *minus* 1-in. fraction.

Although augmented from nearby Lochhead and Dysart collieries the majority of the coal for the new washer is drawn at Wellesley and this consists of two qualities, designated types A and B. Owing to the impossibility of mining these two qualities separately shift by shift, or of marketing them mixed, the only alternative to the use of two separate washing plants was to distinguish between the two qualities as drawn and clean each type on a separate working shift. Tubs of coal underground are marked either A or B and if during a shift type A coal is to be cleaned, all such coal drawn during this shift is conveyed direct to the coal preparation plant, while type B coal is loaded into rail wagons. On the next shift type B coal is cleaned by introducing the out-loaded coal to the plant *via* the two wagon tipplers and, at the same time, conveying type B coal drawn during this shift direct to the cleaning plant.

Four raw-coal boom loaders handle the output of the Wellesley pit, two of these being used for each type of coal. These boom loaders, when in the raised position, discharge the coal on to a conveyor for direct transportation to the cleaning plant and in their lowered position discharge to rail wagons. To unload the wagons filled during a shift, the two 35-ton wagon tipplers installed are each designed to discharge 30 wagons per hour. The two tipplers discharge into a common bunker and each is fitted with an automatic wagon-weighing mechanism.

To facilitate ease of operation and to ensure that overloading of the plant does not occur, the coal conveyed from the pit-head is discharged into the common wagon tippler bunker. From this point the coal is carried to a primary screen for separation at 8 in. or 10 in., the larger fractions being then hand-sorted on a picking belt and tramp iron, pit props, or obvious refuse removed. From the picking belt the remaining large coal can either be loaded directly into wagons or passed through a jaw breaker for reduction to *minus* 8 in. or 10 in.

Meanwhile, the natural *minus* 8 in. to 10 in. coal is conveyed to two secondary screens of the shaker type. A Witton-Kramer circular magnet suspended above the conveyor head pulley removes small pieces of tramp iron. The secondary screens divide the coal at 1 in., the *plus* 1-in. material being delivered to the 16-ft. diameter Chance cone and the *minus* 1-in. fraction being transported to a 1,000-ton capacity bunker *en route* to the old washery.

The Chance cone has been designed to produce from a raw-coal feed three products—namely, clean coal, middlings, and refuse. Sand and water is removed from the clean coal by two shaker type screens and is then graded into three sizes, 8 in. to 10 in. by 3 in., 3 in. by 2 in., and 2 in. by 1 in. Any degradation that has occurred during the passage of the coal through the washer is by-passed to the *minus* 1-in. raw-coal belt delivering to the 1,000-ton bunker.

The middlings from the cone are also desanded and dewatered before passing to a single-roll crusher for reduction to *minus* 1½ in. The product of the crusher is then conveyed to the secondary screens, where the *plus* 1-in. fraction is permitted to recirculate through the washing system.

A further shaker screen desands and dewaters the refuse extracted from the underside of the Chance cone before it is conveyed to a reinforced concrete bunker. This bunker has been constructed so that refuse can be disposed of by rail wagons or dumper trucks.

The 1,000-ton raw-coal bunker serves as a storage facility linking the installation with the existing washery. A scraper conveyor situated above the bunker distributes the raw coal evenly to the three compartments. From these compartments Sherwen electromagnetic feeders discharge the coal on to belt conveyors which carry it to the Baum washer.

These notes have been supplied by the Engineering Group of the General Electric Company.

TBE for Beryl Recovery

A note in the *TBE** *Bulletin* for July discusses "The Recovery of Beryllium Minerals by the TBE Process". The authors, A. Mitzmager and J. Mizrahi, say that the importance of beryllium in recent years as a strategic metal has outgrown the advances in methods for economic concentration of its minerals. From the more than 30 known beryllium minerals, beryl, phenacite, and bertrandite are the most important and they occur mainly in pegmatite deposits, together with feldspars, quartz, micas, and other common pegmatite minerals. The principal source of beryllium is, however, beryl. To date the method used for extraction of beryl from pegmatites which accounts for the great majority of beryllium ore production, has been sorting and hand cobbing,[1,2] although flotation methods have been the subject of much study and some pilot plants are operating. Ores which have to be ground to fine sizes in order to release the beryl are not yet generally exploited. A comprehensive review of methods proposed for the concentration of beryl, has been made by S. W. F. Patching.[3] Most of the work to date has been done by the U.S. Bureau of Mines (mainly on flotation) and, although laboratory results were sometimes satisfactory, plant-scale tests have not previously been equally successful.

The use of TBE for industrial concentration of beryl and other beryllium minerals is based on the small difference in specific gravity, between these and the common pegmatite minerals. A graph of specific gravity ranges is given in the accompanying diagram. It can be seen that, although there is some overlapping of specific gravity ranges, quartz and the common feldspars albite, and orthoclase, are lighter than beryl, while anorthite, micas, and garnets are heavier. Bertrandite has a lower specific gravity, while phenacite and chrysoberyl are heavier than beryl. Therefore, in order to recover the beryllium minerals from pegmatites it will be generally necessary to effect two sharp cuts. In order to obtain an efficient separation, liberation of the various minerals is mandatory. However, even with complete liberation, a wide range of specific gravities could occur due to the variability of specific gravity of the plagioclase feldspars and other minerals as a function of their composition. The advantage of TBE for this separation is that, being a true liquid, its specific gravity can be precisely adjusted with a diluent (generally naphtha), and separations can be effected at fine sizes if need be.

Mica presents the problem of shape, because although being heavier than beryl it tends to go with the lighter fraction, lowering the concentrate grade. In cases where mica is a problem, it can be easily separated before the TBE treatment by electrostatic separation or from the TBE final concentrate by flotation. In pegmatites where there is overlapping of the specific gravities, of beryl and plagioclase for instance, the TBE separation could be useful as a pre-concentration step, reducing drastically the amount of gangue. The distribution of BeO according to specific gravity for a pegmatite containing both bertrandite and beryl with quartz, feldspars, biotite, and sericite, is given in Table 1. These figures show that a marketable concentrate can be separated with a recovery of 97·9% BeO. Fraction V contains obviously the bertrandite, while fraction IV contains most of the beryl. When the same mineral was separated in bulk, after grinding to *minus* 10 mesh, at specific gravity 2·815, a concentrate with 8% BeO and 87·5% recovery was obtained.

Table 1

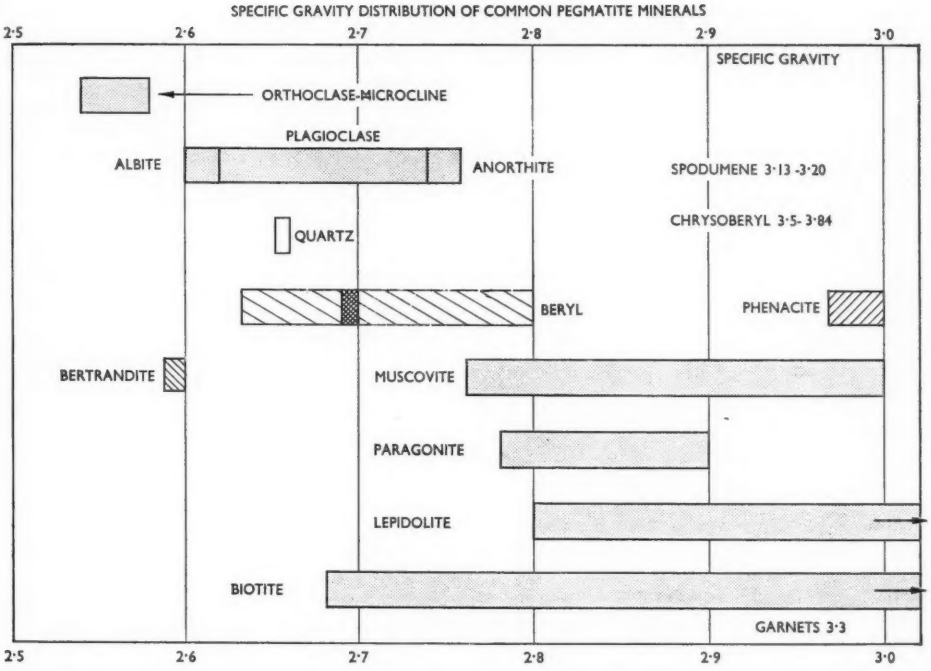
Distribution of BeO *vs.* sp.gr. (*minus* 48 *plus* 100 mesh size)

Fraction	*Sp.gr.*	*% BeO*[4]	*BeO distribution* %	*Weight distribution* %
I	+ 2·915	0·2	1·8	37·0
II	− 2·915 + 2·815	0·06	0·3	22·0
III	− 2·815 + 2·722	1·9	3·3	7·2
IV	− 2·722 + 2·634	7·4	52·4	29·0
V	− 2·634	36·0	42·2	4·8
	Balance . .	4·1	100·0	100·0
Composite III + IV + V	− 2·815	9·8	97·9	41·0

Another example is the separation of beryl from a pegmatite (0·3% BeO) containing also quartz, feldspars, muscovite, garnets, tourmaline, and a number of other minor minerals. The mica was first removed by electrostatic separation, obtaining a marketable mica concentrate. The mica-free fraction was then separated in TBE at specific gravities 2·672 and 2·815. The intermediate fraction contained the beryl with some quartz and residual mica, which were removed by flotation with an alkylamine in acid circuit. The final beryl concentrate assay was 8·0% BeO. Overall recovery was more than 80%. These two examples illustrate the feasibility of the use of TBE in the concentration of

* Tetrabromoethane.

[1] References are given at the end of this article.



beryllium minerals from high- or low-grade ores. Treatment of hand-picked rejects and of low-grade ores becomes therefore an attractive proposition. Furthermore, together with beryl, the production of marketable grades of mica, feldspar, quartz, garnets, etc., also becomes feasible.

[2] EILERTSEN, D. E. "Mineral facts and problems"; Bull. 585, p. 88—*Bureau of Mines U.S.A.* (1960).

[3] PATCHING, S. W. F. "The Flotation of Beryl," 2nd International Congress of Surface Activity, London. 1957.

[4] ADER, D., and ALON, A. "Rapid determination of beryllium. A paper chromatographic method." (For publication in *The Analyst*.)

Underground Settlers

In a paper appearing in the *Journal* of the South African Institute of Mining and Metallurgy for June "An Investigation into the Design of Underground Settlers" is described by J. W. de Villiers. The paper describes the results of investigations carried out on existing settlers and experiments conducted with models in an endeavour to determine the important hydraulic principles involved in sedimentation and how these can be utilized in the design of high-performance settlers for use underground, where space is at a premium.

The author says that underground water usually contains high concentrations of solids in suspension over the working shift. These vary in size down to almost colloidal, the sedimentation of a major portion of the solids in suspension presenting no problem. The real problem is the removal of fine particles which form a more or less stable suspension, to achieve the required degree of clarity. Information is not available to indicate what the most economical degree is likely to be. Within limits the aim should be to obtain a high degree of clarity for the following reasons :—

(i) Solids not removed in the settling sumps are liable to settle in the "clear water" dams, which cannot be designed for easy cleaning and

usually have to be manually swept. There is also the danger that when these dams are emptied large concentrations of solids can be washed into the pumps.

(ii) Solids in suspension promote pump wear, the amount of wear depending on : (*a*) The head being pumped against ; (*b*) the hardness of the suspended particles relative to that of the metal from which the pump parts are made ; (*c*) the size or mass of the particles, and (*d*) the concentration of solids in suspension.

(iii) Two typical destinations of underground water are :—

(*a*) The water may be recirculated for use in rock-drills.

(*b*) The water pumped to surface may eventually find its way into streams. To guard against contamination, and possibly to recover gold-bearing solids, it may be necessary to provide further settlement on surface if the underground clarification is inadequate.

The ideal settler, it is suggested, may be defined as a sump or container in which the water containing solids in suspension is at rest or stagnant. Water containing finely-divided solids in suspension with a specific gravity greater than unity will tend to behave like a homogeneous liquid with a specific gravity greater than unity and the actual specific gravity will depend on the concentration and nature of the solids in suspension. As a portion of the solids is precipitated the specific gravity of the residual suspension will decrease. The specific gravity of the contents of the ideal settler will therefore vary from that of clear water at the top to that of settled mud at the bottom. At any instant, however, the density throughout each horizontal plane will be constant. Before settlement commences the solids of various sizes are assumed to be evenly distributed throughout the volume of the water. As settlement takes place a certain amount of classification takes place, but both small and large particles will continually be deposited on the bottom. The mud in the bottom will therefore be a mixture of large and small particles. Due to classification, however, a portion of the smaller particles will lag behind the main body of settling particles. It is the elimination of this small portion of the total suspended particles that presents the problem in sedimentation. The larger particles and a great proportion of the smaller particles look after themselves.

As the output of a settler is proportional to its surface area the design of an underground settler must be such that maximum surface area is obtained per unit volume of excavation. The nature of the ground may be such that wide excavations are undesirable and expensive. In these circumstances the settlers must be compact enough to fit into low and narrow excavations. They must be able to handle the variations in flow, solid content, and settling velocity, that may occur over the 24 hours. They must require little supervision and maintenance.

There are, the author says, a number of possible designs for underground settlers embodying the above principles. Two designs can be fitted into a long narrow excavation by dividing it into different compartments : In one the influent is taken to below the bed of settling particles behind a wall. The length of the horizontal flow is governed by the width of the excavation. This design gives good results and is comparatively easy and inexpensive to construct. In the second the length of the horizontal flow is considerably reduced, being only half that of the opening at the bottom of the divergent upward flow portion. This opening must not be made too narrow, as this would trap the settling particles in the upward-flow portion and create unstable conditions. In both cases the settled mud must not be allowed to accumulate to such an extent that the openings at the bottom of the walls become restricted, as this would result in settled particles becoming re-entrained.

To maintain a reasonably high flow rate and at the same time obtain an effluent with a high degree of clarity from a suspension containing a large percentage of fine particles, which form a more or less stable suspension, filtration may have to be employed as a secondary stage to sedimentation.

In experiments conducted it was found that a settler working at or near its maximum flow rate produced an effluent of clarity better than that obtainable by allowing the suspension to settle in a vessel under stagnant conditions for a comparable period of time. This indicates that some of the smaller particles were removed from the water in its upward passage through the bed of settling particles by a mechanism which, for the purpose of the paper, is referred to as " dynamic filtration. " Dynamic filtration may therefore be defined as the removal of some of the suspended particles in their upward passage through a bed of suspended particles by virtue of the interference offered by the other, usually larger, particles in suspension. The clarity of the effluent will therefore be dependent on the amount of interference encountered, provided that the smaller particles at the top of the bed of suspended particles do not disperse and become re-entrained in the water.

A model filter has proved successful; pre-sedimentation of the heavier particles is necessary before the water enters the filter. In this model the filter bed is kept at a constant depth by positioning draw-off points at the upper level of the bed so that the excess solids are virtually decanted from the bed at the same rate as they are being replenished by the influent. Variations in flow are catered for by a variable density in the filter bed which, because of agitation, is relatively constant throughout its depth and occupies the whole Vee-shaped section. For maximum flow the filter bed must be at the minimum density required for "filtering." To minimize the chances of "piping" the influent is introduced at a number of points below the filter bed by means of independent pipes. The high density of the filter bed is balanced against a higher head of less-dense influent in the inlet pipes. Further dewatering of the excess sludge drained from the filter bed takes place in the bottom compartment.

With flocculated underground water containing no particles over 15μ the model worked satisfactorily. The best results were obtained with a flow rate of 2·8 gal. per sq. ft. of filter bed per min. The corresponding percentage of solids in the filter bed was 5·45 and the deep cell count of the effluent was 4·3 particles per cc. $\times 10^6$. A very significant point in the performance of this model is the fact that the highly-concentrated sludge from the filter bed flowing through the draw-off pipes flows through the clear water in the bottom compartment and is deposited on the bottom without any tendency to disperse and mix with the water. This filter shows promise, it is suggested, as it is stable, operates satisfactorily over a wide range of flow rates, and requires no adjustment and very little supervision.

The author summarizes as follows :—

(i) The performance of a settler unit per area depends on the settling velocity of the smaller particles.

(ii) Water containing solids in suspension has a specific gravity greater than 1 depending on the amount of solids in suspension. Underground, specific gravity variations due to temperature are not significant.

(iii) The specific gravity of a suspension will diminish as solids settle out.

(iv) Because of this changing specific gravity streamline flow can be achieved vertically upwards but not horizontally.

(v) In a condition of rest the suspension will have a density gradient from that of clear water at the top to that of settled mud at the bottom.

(vi) Influent entering a settler will travel downwards until it reaches a layer of equal specific gravity and will flow along this plane horizontally and finally rise to the overflow at the surface.

(vii) Any particle that has a settling velocity less than the vertical component of the upward velocity of the water will be carried up to the overflow unless arrested by collision with larger particles.

(viii) For a given flow rate per unit surface area of settler the upward velocity of the water is least when the flow is vertical over the whole area of the settler. Optimum performance can therefore be expected, as streamline flow is possible vertically upwards.

(ix) To obtain this condition the design of the settler should be such as to ensure the minimum distance of flow in a horizontal direction for the influent—*i.e.*, transverse flow in a longitudinal excavation—and as many draw off points as possible, evenly spaced over the surface of the settler, must be provided to remove the effluent.

(x) The influent should be introduced in such a manner as to avoid disturbing the "near-stagnant" conditions in the upward flow settling zone—*i.e.*, introduction should be below this zone.

(xi) For "dynamic filtration" to occur certain minimum requirements relating to density and depth of filter bed are necessary.

Trade Paragraphs

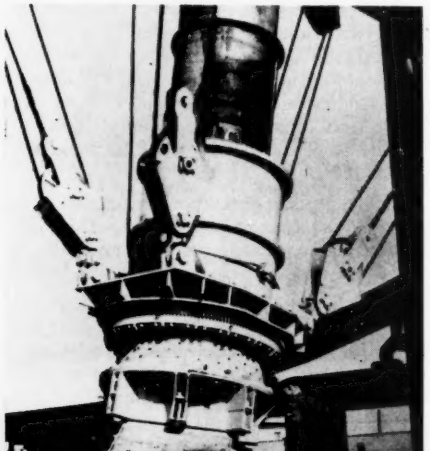
Bowmaker (Plant), Ltd., recently opened a new south-western depot in the Pinhoe Estate, Exeter, designed to deal with all types of Caterpillar earth-moving equipment including servicing. The new depot will take the place of that previously established at Fenny Bridges.

Denver Equipment Co., of 1400 17th Street, Denver, Colorado (London office: 15–17, Christopher Street, Finsbury Square, E.C. 2), in a recent leaflet call attention to their ball and rod mill specification manual. The leaflet also contains a note on a combined rod-mill and ball-mill grinding "team" in a 500 ton-per-day base-metal selective flotation mill.

Simon Engineering, Ltd., of Cheadle Heath, Stockport, announce that the coal preparation and mining division of **Simon-Carves, Ltd.,** is being transferred to Carlisle and after December 31,1961, their address will be P.O. Box No. 26, Durranhill, Carlisle. The **Automatic Coal Cleaning Co., Ltd.,** already operate from this Carlisle address and the integration and closer co-operation should prove of benefit.

Johnson, Matthey and Co., Ltd., of 73–83 Hatton Garden, London, E.C. 1 announce that they are now producing zone-refined tellurium of high purity. The total metallic impurity content, excluding selenium, is less than 5 p.p.m. and is normally in the region of 1 p.p. m. The selenium content does not exceed 5 p.p.m. It is supplied as half-round bar approximately 1 in. by ½ in.

Clarke, Chapman and Co., Ltd., of Gateshead, have produced a 22-page illustrated booklet which describes the range of their manufactures. The products shown include those of their associates E. N. Mackley and Co. and is chiefly of interest to marine engineers. Of more general interest, however, are various types of Mackley pumps, lifting and haulage gears, including mine winders, skip hoists, and mine lighting.



Slewing Coal Trimmer.

Recon (Pipelines), Ltd., of Sheerwater, Woking, call attention to Vacuflex—now available in large sizes—and its suitability for ventilation and dust and fume extraction ducting. Vacuflex is lighter and easier and cheaper to install. It can be bent round obstacles in any plane without the need for fabricating of elbows and bends and, being made of flame-resistant P.V.C., has better thermal insulation.

Roballo Engineering Co., Ltd., of 43, Dover Street, London, W. 1, refer in a note to the illustration here of a coal trimmer which is equipped with a double-row ball-bearing slewing ring with external gear having an overall diameter of 7 ft. 1 in. This is at a coal-handling installation at Presque Isle, Toledo, for loading ships with a throughput of 6,000 t.p.h. The distributing chute was made by the Chesapeake and Ohio Railway Co., of Richmond.

Head Wrightson and Co., Ltd., of 20, Buckingham Gate, London, S.W. 1, have compiled a well-illustrated 26-page booklet with text in four languages designed to give an idea of the company's activities and diversification of interests In addition to pictures in colour of works interiors there are illustrations of ball-mill construction, a skip plant installation and tipper in a rock-salt mine, steelworks sinter plant, and surface plant at a colliery for coal washing—to mention a few.

Sandvik Steel Works Co., Ltd., of Sandviken, Sweden, announce the recent opening by H.M. the King of Sweden of new research laboratories devoted to metal physics and process metallurgy and others for tubes and bars and strip and wire. The basic purpose of the new extensions is the further development of the company's existing steel specialities, among which are the tungsten carbide tipped rock-drill tools which the company produce in collaboration with the Atlas Copco group.

Air Pumps, Ltd., of Raynes Park, London, S.W. 20, have produced a 24-page illustrated booklet detailing the range of their oil-cooled mobile rotary compressors. This includes particulars of their 250, 365, and 600 c.f.m. models in operation on various sites as well as giving specifications of the engines used. It is also announced that a new 130-c.f.m. self-propelled power pack compressor, is now available, known as the "Travelair". It consists basically of Ford Thames 15 cwt. components with a Ford 592E four-cylinder diesel engine driving an airflow-cooled two-stage compressor.

Rapid Magnetic, Ltd., of Lombard Street, Birmingham, introduce means of avoiding premature release (due to supply failure) of tramp iron extracted by electro suspension magnets. Auxiliary built-in permanent magnets retain the collected iron until the holding force is neutralized by operating the contactor controller and reversing the current. The technique can be applied to any of the wide range of circular, square, or rectangular suspension magnets produced, it is stated.

Allen West and Co., Ltd., of Brighton, in a four-page leaflet describe and illustrate a new range of unit contactors which are said to be particularly suitable for multi-contactor assemblies and are for front fixing and wiring and mounted on a metal base-plate. Three sizes are available for ratings of 15, 25, and 50 amps. In a more recent statement they announce that the company have acquired the manufacturing interests of the Digital Engineering Co., Ltd., of 136, Battersea Park Road, London, S.W. 11, whose products range from performance recorders of all kinds to digital convertors and complete on-line digital information handling schemes.

George Fletcher and Co., Ltd., of Masson Works, Litchurch Lane, Derby, state that they have in recent months successfully installed Desford hydraulic chocks of a new design in the East Midlands Division of the N.C.B. The chocks now available have N.C.B. approval and, designed in a range of sizes, can work with a 14-in. stroke in a 3-ft. seam or with an 8-in. stroke in a seam of 2 ft. 1 in. The relief valve mechanism with the chocks can be set according to specification to provide a range of working loads from 50 tons to 100 tons. Auxiliary equipment includes double-acting hydraulic rams with up to 2 ft. 6 in. stroke, extension pieces, and detachable ram anchor brackets.

Nordberg Manufacturing Co., of Milwaukee, Wisconsin, (London office : 19 Curzon Street, W. 1) have issued an illustrated folder to describe the story of Nordbak, originally developed for use in Symons cone-crushers and now widely used for that purpose as well as in gyratory crushers, grinding mills, and other machinery where backing agents are required. The safe simple procedures for backing crusher members on the job are shown and described. The superior backing qualities of Nordbak also are clearly shown by means of photographs. Order requirements for shipping of Norbak are explained and a prepared chart lists quantity requirements for both standard and short-head cone-crushers.

Associated Electrical Industries, Ltd., of Crown House, Aldwych, London, W.C. 2, have produced a pump whose working parts are composed entirely of p.t.f.e. Chemical inertness and imperviousness to corrosive action are important properties of p.t.f.e. and the pump will be particularly useful for handling corrosive fluids or liquids which must be protected from contaminating influences. The new pump is a diaphragm type and self-priming. Delivery at a 1-ft. head is 2 litres/minute and at the maximum working head of 15 ft. is 1·25 litres/minute. Power consumption is 50 watts. Attention is also called to a new p.t.f.e. coupler, which is a spring-loaded telescopic unit that expands to grip the tubing inserted at each of its ends.

English Electric Co., Ltd., of English Electric House, Strand, London, W.C. 2., described in a recent note their multi-motor control centre, designed to enable a series of motors of different powers ranging from fractional to 400 h.p., to be started from some convenient central point by means of centralized contactors, control wiring, and interlocking devices. In a typical control centre the smaller starters (up to 25 h.p.) are mounted in banks on compartment doors to form separate " swing out " units, while the medium starters (up to 100 h.p.) are mounted in " draw out " chasis compartments. The larger horse power and more complex starters are mounted in fixed panels. The only external links necessary from control centre to motors are the power carrying cables.

Le Grand Adsco, Ltd., of The Green, Southall, Middx., have produced a well-illustrated booklet which sets out the services they have to offer in water-well and exploratory drilling, site investigations and soil mechanics, geological and geophysical surveys, and pump installation and maintenance. Among contracts completed are those for Burma Corporation, the U.K. Atomic Energy Division of the Geological Survey, and the Geological Survey of India respectively for lead-zinc and uranium. Reference is also made to core drilling for iron ore in India and to shaft sinking and adit driving. A separate publication by **Site Investigations Co., Ltd.,** of the same address calls attention to work that can be undertaken in geophysical surveys by a variety of methods and in bore-hole logging and other activities.

Wilkinson Rubber Linatex, Ltd., of Camberley, Surrey, issue a statement with reference to the highly-developed range of Linatex pinch-type valves which has now been expanded to embrace motorised and pneumatically operated types. After considerable experience with the standard handwheel-operated valve in sizes

from ½ in. bore to 8 in. bore these have now also been extended to include 10 in., 12 in., and 14 in. bores. The pinch type valve is particularly suitable for handling slurries and powders. The valve is glandless and the basic design greatly facilitates maintenance since it is necessary only to change the rubber sleeve from time to time. This sleeve, expecially when the valve is used for handling abrasive material, is made of Linatex rubber as incorporated in the company's pumps, pipelines, and other material-handling equipment.

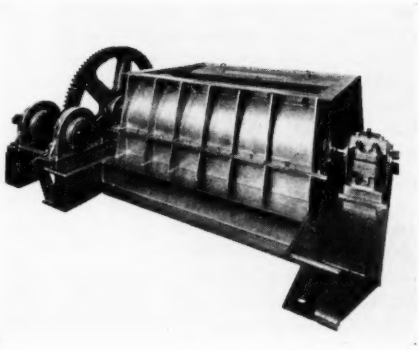
Glacier Metal Co., Ltd., of Alperton, Wembley, Middx., issue some notes on dry-bearing surface treatments from which the following is taken :—Bearings which can be run dry and unlubricated are playing an increasingly important part in industry. Glacier has made a major contribution to this new advance by the development of processes which permit parts of components used as bearing surfaces to be treated with materials which give a very low friction wear-resistant surface. The materials used are code named D.G. and D.L. The former is based on polytetrafluoroethylene (p.t.f.e.) the properties of which are now becoming well known, and the latter on molybdenum disulphide. Full details of these treatments are given in their Designers Handbook No. 2. The treatments can be applied to components which for various reasons cannot be redesigned or modified to make use of the company's standard dry bearings and strip.

Wickman, Ltd., of Banner Lane, Coventry, from the Mining Division at Bottrill Street, Nuneaton, announce that they can now offer for universal application on drum shearers their slug-insert beak type shearer pick. The pick, developed by extensive trials in the East Midlands Division of the N.C.B. has led to substantial reductions in power requirements together with an increase in the large coal content. Since the introduction of the slug-insert beak shearer there has been a considerable reduction in the total number of picks used. The time lost in replacing pick discards has been reduced to a minimum and ammeter readings taken during the cutting period showed that the machine was consistently operating at between 80 and a maximum of 90 amps. as opposed to the previous rating of 80–120 amps. The tests, carried out by N.C.B. staff, showed that 257 conventional-type picks were discarded in cutting 8,418 yd. at a cost of 5/8d. per ton of coal produced. In cutting 5,107 yd., 28 slug-insert beak shearer picks were discarded at a cost of 2·4d. per ton of coal produced, despite a higher initial cost.

Alan Muntz and Co., Ltd., of Browell's Lane, Feltham, Middx., issue details of their compressor output tester. They point out that when operating an air-compressor it is an advantage to be able to check the output at intervals so that a reduction in performance or a mechanical failure can be detected in the early stages. In addition it is also useful to check the output after overhaul to make sure that the performance and control adjustment is correct. The tester consists of an accurately-machined nozzle fitted at one end of a steel body, the other end being screwed to fit on to the off-take cock. A pressure gauge and a thermometer are fitted. Two nozzles are provided, the $\frac{6}{16}$ in. diameter size covering the range 54 c.f.m. to 148 c.f.m. and the $\frac{7}{16}$ in. diameter from 90 c.f.m. to 290 c.f.m. A blank plug is also supplied so that when fitted in place of the nozzle and the off-take cock is opened the pressure gauge on the machine can be checked against that on the tester.

BTR Industries, Ltd., Herga House, Vincent Square, London, S.W. 1 state that over 4,500 ft. of Tuftex fire-resistant conveyor belting has been supplied to the N.C.B. for Pit House Drift. This latest development in the company's conveyor belting is a patented construction consisting of a continuous filament stress member with a cotton cover warp and a continuous filament nylon weft and represents a major departure from conventional methods of weaving fabric. The drive unit at Pit House Drift is a Meco 300-h.p. machine with an electrically controlled scoop-type hydraulic coupling. The length of the conveyor is 2,199 ft. 4 in. between centres and the gradient of the drive varies from being almost flat at load point to 1 in 4·36, and the total lift is 478 ft. Without shock or surge the belt can be accelerated to 421 ft. per min. in 10 seconds and can be stopped smoothly under capacity load in 5 seconds. The belting supplies is of 3-ply construction only but has a breaking stress of over 6,000-lb./in., is designed to operate at a maximum tension of over 600-lb./in., and was manufactured in four lengths each of approximately 1,200 ft. and each weighing 5 tons. The joints were vulcanized on site.

General Electric Co., Ltd., of Erith, Kent, recently shipped to Africa two identical 60 in. by 24 in. Pennsylvania single-roll crushers, specially developed for handling hot zinc-lead sinter. These crushers, which were manufactured at the company's Fraser and Chalmers Engineering Works, were ordered by Messrs. Lurgi of Frankfurt and are for installation in two up-draught sinter plants at Broken Hill,



Rhodesia (see illustration). When operating each crusher will be fed with hot sinter from a pallet 59 in. by 39 in. by 12 in. and, according to its setting, will give a product size of either 3 in. or 4 in. at a rate of 48 tons per hour. Each crusher has a frame of fabricated construction housing an alloy-steel toothed roll and a readily-adjustable steel breaker-plate. The crushing roll is driven at a speed of 20 r.p.m. by a 25-h.p. squirrel-cage motor through a Twiflex coupling and a David Brown worm-gear box. Special grease labyrinth seals are used with the sleeve type bearings of the main shaft and there is also provision for water-cooling of the shaft in the vicinity of these bearings. Split roller bearings carry the countershaft. To avoid damage to the machine if it is overloaded, or if it receives an uncrushable object, spring-loaded toggles are fitted which allow the breaker-plate to open and reset automatically.

Mine Safety Appliances Co., Ltd., of Glasgow, are now producing an accurate and robust portable instrument for the detection of methane in mine air. Called the M.S.A. general purpose methanometer, this self-contained non-automatic firedamp detector is fully approved by the Ministry of Power. It is illustrated here. The standard instrument has a range of 0% to 5% methane, the meter scale being in 0·2% divisions, and is easy to operate, a button on the front of the case being depressed while a sample of the air to be tested is passed through the methanometer by means of an aspirator bulb. Because filament life is long no provision for replacement has been made. The flow system and electrical circuit with the exception of the calibration resistance have been encapsuled in an epoxy resin contained in a nylon moulding. Another nylon moulding forms the battery container. The indicating meter is separately mounted on rubber.

The instrument is powered by two Mallory mercury cells with a capacity of 14,000 mAh and at least 6,000 tests can be made with one set of batteries under normal working conditions. The state of the batteries may be checked at any time by depressing the meter button and closing a micro switch in a recess at the back of the instrument. Should the resultant meter reading fail to reach a predetermined level indicated on the instrument the batteries should be replaced. The instrument is self-zeroing and self-compensating for changes in battery voltage over the operating range. A zero control is provided, but this is accessible only if the case is opened.

Normal changes in atmospheric pressure, temperature, or humidity have no effect upon accuracy of the readings.

The components are housed in a stainless-steel case measuring $8\frac{1}{4}$ in. by $3\frac{1}{16}$ in. by 2 in. deep and the complete instrument weighs less than 3 lb. An armoured-glass window protects the indicating meter. Special provision has been made for using the methanometer with a sampling probe—an accessory designed for obtaining samples from roof level in high roadways or other inaccessible places.

NEW BOOKS, PAMPHLETS, ETC.

☛ Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

A Dictionary of Geology: By JOHN CHALLINOR. Cloth, octavo, 256 pages. Price 30s. Cardiff: University of Wales Press.

Field Geology: By FREDERIC H. LAHEE. Sixth edition. Cloth, small octavo, 926 pages, illustrated. Price 83s. 6d. London: McGraw-Hill Publishing Co., Ltd.

Mines and Miners of Cornwall: By A. K. HAMILTON JENKIN. Part I.—Around St. Ives. Paper covers, 50 pages, illustrated, with sketch map. Price 7s. 6d. Truro: Truro Bookshop.

Proceedings of The United Nations Seminar on Aerial Survey Methods and Equipment: (Bangkok, 1960). Mineral Resources Development Series No. 12. Paper covers, 168 pages, with 43 figures. Price 21s. Geneva, Palais des Nations: U.N. Sales Office.

Mining Developments in Asia and the Far East, 1958: U.N. Mineral Resources Development Series No. 13. Paper covers, 37 pages. Price 10s. 6d. Geneva, Palais des Nations: U.N. Sales Office.

Copper, Lead, and Zinc Ore Resources of Asia and the Far East: U.N. Mineral Resources Development Series No. 14. Paper covers, 63 pages, illustrated. Price 14s. Geneva, Palais des Nations: U.N. Sales Office.

Northern Rhodesia: The Geology of the Sinda Area (Explanation of Degree Sheet 1431, N.E. Quarter). N. Rhod. Geological Survey Report No. 9. By K. A. PHILLIPS. Paper covers, 27 pages, with plates and map. Price 15s. Lusaka: Government Printer.

Minerals of California: Supplement, 1955 through to 1957, Calif. Division of Mines Bulletin 173. By J. MURDOCH and R. W. WEBB. Paper covers, 64 pages. Price $1·00. San Francisco: Division of Mines.

Dust-Tight Enclosures for Electrical Apparatus: Examination of a Proposed Method of Test. E.R.A. Research Report D/T118. By H. G. RIDDLESTONE and R. W. CORAM. Paper covers, 11 pages, typescript, with 3 plates. Price 10s. 6d. Leatherhead: British Electrical and Allied Industries Research Association.

High-Nickel Alloys in Pickling Plant: Paper covers, 27 pages, illustrated. London: Henry Wiggin and Co., Ltd.

South African Electrical and Power Year Book: 1961 edition. Cloth, quarto, 228 pages. Price R. 6·30. Johannesburg: South African Engineer and Electrical Review and Power Magazines (Pty.), Ltd.

The Nuffield Foundation: 16th edition, year to March 31, 1961. Paper covers, 210 pages. Oxford: The University Press.

Gauge and Tool Makers' Association: Members Handbook, 8th edition. Paper covers, 96 pages. London: Gauge and Tool Makers' Association.

Republique du Cameroun: Notice Explicative sur la Feuille Garoua-Ouest. By P. KOCH. Paper covers, 48 pages, with map. Paris: Librairie Thomas.

RECENT PATENTS PUBLISHED

☛ A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

21,041 of 1957 (869,367). COMMONWEALTH OF AUSTRALIA. Separation of solid particles by electrophoretic means.

1,328 of 1958 (871,831). E. I. DU PONT DE NEMOURS AND CO. Production of elemental silicon.

255 of 1959 (869,966). FARBENFABRIKEN BAYER A.G. Calcination of silicate materials.

8,253 of 1959 (870,072). SOIL MECHANICS, LTD. Lining of shafts excavated in soil.

10,675 of 1959 (870,560). ALLIED CHEMICAL CORPORATION. Process for the production of titanium.

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25,083 of 1959 (870,930). UNION CARBIDE CORPORATION. Production of columbium and tantalum.

39,484 of 1959 (871,395). SOC. D'ELECTRO-CHIMIE, D'ELECTRO-METALLURGIE ET DES ACIERIES ELECTRIQUES D'UGINE. Process of producing manganese and ferro-silicon simultaneously.

Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE. † Article digested in the MAGAZINE.

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Fuel, India : *Problem, Coal.* Central Washeries—Key to India's Coal Problem. G. G. SARKAR and others, *Min. Engg.*, July, 1961.

Haulage, Canada : *Transport, Mineral.* Transportation of Minerals in Northern Canada. A. DUBNIE, *Canad. Min. Inform. Bull.* MR 50.

Production, Africa : *Copper, Congo.* Katanga—The Copper Market's Unknown Quantity. G. EVERWYN, *Rhod. Min. J.*, June, 1961.

Production, Africa : *Survey, Katanga.* Mining and Metallurgical Progress in Katanga. *S. Afr. Min. Engg. J.*, June 23, 1961.

Production, Australia : *Operations, Mount Isa.* Review of Operations, Mount Isa Mines, Ltd., 1952–1960. J. W. FOOTS, *Proc. Aust. Inst. Min. Metall.*, Mar., 1961.

Production, Canada : *Asbestos, B.C.* Cassiar Asbestos Mine. *Precambrian*, June, 1961.

Production, United States : *Costs, Mining.* How Industrial Engineering Helps to Cut Costs at Calumet and Hecla. R. F. BREDIN, *Engg. Min. J.*, July, 1961.

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Economic, Australia : *Mineral, Queensland.* Notes on Mount Isa Geology. W. J. MURRAY, *Proc. Aust. Inst. Min. Metall.*, Mar., 1961.

Economic, Canada : *Lead-Zinc, B.C.* The River Jordan Lead-Zinc Deposit, Revelstoke Mining Division. C. RILEY, *Canad. Min. Metall. Bull.*, June, 1961.

Economic, Canada : *Mineral, Quebec.* Geology and Ore Deposits of the Mattagami Area, Quebec. C. P. JENNEY, *Econ. Geol.*, June–July, 1961.

Economic, South Africa : *Sillimanite, Namaqualand.* The Sillimanite Deposits in Namaqualand, near Pofadder. D. H. DE JAGER, J. W. VON BACKSTRÖM, *S. Afr. Geol. Surv. Bull.* 33.

Regional, Africa : *Sinda, N. Rhodesia.* The Geology of the Sinda Area. K. A. PHILLIPS, *N. Rhod. Geol. Surv. Report* No. 9.

Regional, United States : *California, Southern.* Geology of the San Bernardino Mountains North of Big Bear Lake. J. F. RICHMOND, *Spec. Report* 65, Calif. Div. Mines.

Search, Ore : *Theories, Review.* Geological Theory and the Search for Ore. R. L. STANTON, *Min. Chem. Engg. Rev.*, Apr. 15, 1961.

Survey, Canada : *Prospecting, Nova Scotia.* Prospecting for Metallic Minerals in Mississippian Rocks of Cape Breton Island. D. G. KELLEY, *Canad. Min. J.*, June, 1961.

***Survey, Geophysical :** *Coast, Cornwall.* Survey Around the Cornish Coast. THE MINING MAGAZINE, Aug., 1961.

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***Titanium, Review :** *Uses, Development.* Developments in Titanium. M. SCHOFIELD, THE MINING MAGAZINE, Aug., 1961.

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†**General, South Africa :** *Platinum, Transvaal.* Platinum Mining at Rustenburg. *Plat. Metals Rev.*, July, 1961.

General, Sweden : *Methods, Review.* Some Observations on Mining in Sweden. D. J. SMALL, *Mine, Quarry Engg.*, July, Aug., 1961.

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Opencast, United States : *Coal, Ohio.* Mechanization by Peabody Coal Company. C. MAMEN, *Canad. Min. J.*, June, 1961.

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***Comminution, Grinding :** *Steel, Pebbles.* Steel *vs* Pebbles in the Ball-Mill—I. Ore-Dressing Notes, THE MINING MAGAZINE, Aug., 1961.

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†**Gravity, Sink-Float :** *Beryl, Recovery.* The Recovery of Beryllium Minerals by the TBE Process. A. MITZMAGER, J. MIZRAHI, *TBE Bulletin*, July, 1961.

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